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The average life of a timber ore dock on the Great Lakes is from ten to twelve years. The rebuilding of ore docks on these lakes requires yearly from ten to fifteen million feet of lumber. The waning supply and increasing cost of timber makes this a considerable item. It is natural, therefore, that attention should be given to the substitution of steel and concrete for wood in the construction of these docks. The Duluth & Iron Range Railroad has already built such a dock—the first in America. In a recent paper before the Northern Railway Club, W. A. Clark, chief engineer of this road, discussed the merits of this construction as compared with timber. Ore docks of permanent construction would not have been justified until recently because of the rapid growth in size of lake vessels. But now it is felt that boats have about reached their limit of draft, unless large amounts of money are spent in dredging harbors and passages; therefore it is not likely that their length and beam will be increased much. Under these circumstances a dock construction which will be good for 25 or 30 years at least, and costs only about two and one-half times as much as timber, is justified. Important advantages are the minimized fire risk, with consequent low insurance and security against interruption to use. In his paper Mr. Clark states that in placing the concrete for the foundations of the dock the cement under water was very slow in setting because of the low temperature of the water, and was therefore in danger of being washed out of the aggregate before it could set. It was therefore decided to heat the water. To do this the contractors ran a pipe, carrying steam at 60 lbs., the length of the dock and by means of hose discharged steam into confined areas, each about 18 ft. x 50 ft. This raised the temperature of the water to about 45 deg. Fahr., and helped greatly the initial setting of the cement. The pockets of the dock are wood, though a few have concrete partitions as an experiment and have proven satisfactory. The use of reinforced concrete for pockets was suggested, although they would probably have to be wood-lined to prevent the heavy pieces of ore from chipping and roughening the concrete surface.

The increasing expense of track maintenance, due to tie renewals and the more extensive use of tie plates, suggests some reference to a foreign practice which we believe has not been tested in this country and may not be generally known. On the Prussian State Railways slabs of elastic material are used as bed plates in the permanent way for preventing or reducing noise on bridges, for protecting wooden bridge beams and switch ties, for preventing the wear of the rail seat on metal ties, and generally for reducing the rigidity of the track, at crossings, switches and bridges where the rolling stock is subjected to severe shock and the track material to rapid wear. Felt, leather and woven fabric slabs have all been used as elastic bed plates. It was found that felt slabs became hard, and lost their elasticity, and consequently their property of reducing the hammering and noise. Leather slabs have been more successful. They are made of strong bullock hide, $\frac{5}{16}$ to $\frac{6}{16}$ in. thick, and cost about 75 cents to $1 per sq. ft., depending on thickness. These leather slabs have been in use on the Prussian state lines since 1901 on bridges and switches, and are still in good condition. They are placed between the metal bridge girders and the ties, and at switches between the rail and the metal tie. In both cases the desired object of reducing noise and protecting the ties was fully attained. As the elasticity of these slabs has not become impaired after eight years' service, they are regarded as a very satisfactory method of preventing rigid metallic hammering, and they not only save the rails and ties but the rolling stock as well, and doubtless prevent many fractures which are ordinarily produced by shock where the rail is so rigidly supported but not entirely smooth or continuous. Woven slabs have also been used extensively for the same purpose. They are made of layers of woven material and of felt sewn together, compressed to $\frac{13}{16}$ in. thickness and impregnated. They were first used in 1903 for protecting pine ties at switches and for preventing noise, and cost about 50 cents per sq. ft. It was found that they would not withstand the hammering at switches and that they pressed out laterally. When rails are laid on metal bed plates on masonry these woven slabs have been found useful in preventing the plates from being driven into the masonry. The manufacturers of woven slabs claim that for tie plates in main line track they have given satisfactory results and shown a life of six years, the ties showing no appreciable wear; whereas, the metal tie plates have been appreciably driven into the ties where the woven slabs were not used. From the additional life given to the ties they show that the use of the elastic woven slab is economical. There are numerous places in railway track where noise is a sure indication of undue wear, and the use of an elastic medium, such as these here described, in the track at street crossings of elevated lines in cities, or at track crossings where the rails wear rapidly and the rolling stock is often damaged, would often improve conditions materially, not only in the prevention of noise but in a saving in cost of maintenance. It is also probable that the addition of the elastic slab between the rail and the steel tie or concrete tie, would improve

conditions in the experiments now being made with such ties in this country. They would have a tendency to reduce the wear, stop much of the noise and render the fastenings more secure. The German practice as above briefly described may therefore be worthy of further investigation.

That portion of the report of the Committee on Iron and Steel Structures of the American Railway Engineering and Maintenance of Way Association which deals with impact tests is quite brief, consisting of a tabulated description of the work done during the past year and a short statement regarding the magnitude of the detail work of analyzing the records. The report states that about 15,000 records on tests have been secured and that there has not been sufficient time in which to properly study and analyze these records. This is altogether reasonable, of course, and the committee has acted wisely in declining to present any conclusions, even temporary ones, which must be based on incomplete analyses. A necessary postulate of the Maintenance of Way Association specifications for live loads and unit stresses is the ability to calculate stresses in the structure to as complete a degree as possible. The tendency of engineers during the last 10 years has been to "edge up" on unit stresses, gradually increasing the allowable stress, which has culminated recently in two or three deplorable examples of over-confidence, with which our readers are familiar. The only safe basis for unit stresses exceeding one-third of the elastic limit of the material is in absolute knowledge of the stresses to be carried, and the work of the committee on Impact Tests is bound to bear good fruit if it is properly considered before conclusions are presented. When this shall have been done, it is reasonable to assume that at least one of the now almost unknown elements of live load stress will have been evaluated, or at least that a substantial addition will have been made to the science of bridge design. It is in such work as this that the Maintenance of Way Association can be of greatest usefulness. There appears to be a tendency, as displayed in some of the reports, to assume to settle, for all time and for all men, many questions which ought not, in the nature of things, to be finally settled. As a clearing house for ideas, for good practice, for the comparison of best methods of railway maintenance, for the sharpening of wits and broadening of view of the keenest and most practical engineers in the country, this association has unequaled opportunities for good, and has already employed them most ably. Therefore, any tendency toward finality, toward the conclusive settlement of all questions presented, should be checked and the association allowed to exercise its fullest opportunities along the lines of improvement of existing conditions and addition to existing knowledge. The brevity of the sub-committee's report on impact tests and its omission to draw conclusions is therefore to be commended rather than otherwise. It is to be hoped that the association will carry this work to a successful conclusion by affording the committee such further support as may be required.

THE ART OF SIGNALING.

Improvements in railway signaling follow one another so fast that to define at any given moment the "state of the art," as courts have to do in patent suits, is a difficult undertaking. Everything is done in a rush, and the more comprehensive "art of railroading" has itself been so much neglected that when any manager sets out to bring his materials and practice up to date he encounters a complex problem and he is likely to require of the signaling department, as well as of other departments, all manner of impossible things. It is very interesting to take a look at the situation, however, even if the aspect be somewhat indistinct.

The letter ballots which have just been announced by the secretary of the Railway Signaling Association are not the least significant indication of the present state of this art. A return of 500 intelligent votes, representing the views of probably 100 enterprising and educated signal engineers, marks a great change from the time, not many years ago, when trained signal experts were few and far between and mostly in the employ of the manufacturers; or even two years ago, when the association had no effective means of recording and clarifying its collective opinion, and contained very few men able and ready to make a well digested report. Under the present constitution the membership of this association, which does the thinking in this important field of railway work, can do the deciding as well; and we believe will do it. With due deference to their elders, the signal engineers will, of course, secure the confirmation of their views by the "AREMOW" (American Railway Engineering and Maintenance of Way Association) before they herald them very loudly; but the older engineers are too busy to do much analyzing in the signal department, unless the proposals which are put forth have important and obvious defects. Still less is the American Railway Association likely to take any useful and positive action unless decided disapproval of some measure may seem to be necessary. Indeed, the question of action or inaction on the part of either of the larger associations may become relatively unimportant, for the proposals of the signal engineers are finding favor on their merits. The two principal codes of specifications, for mechanical interlocking and electric interlocking, are already popular, notwithstanding some defects yet to be cured; and the "comprehensive scheme of signaling" (the upward inclination of the semaphore, etc.) has come into use faster than any like change of so radical a nature ever came into use before.

The signal engineers are making progress in the art of talking as well as in thinking. The debate at Chicago this week must prove valuable and instructive. At this writing the arguments are still hidden in the minds of the four gentlemen who are the principals in the contest, but as these men are among the most astute in the association, we risk nothing in predicting a profitable outcome. A limit of time and the presence of a sharp antagonist give to a speech or an essay a vigor not to be had in any other way. One of the most crying needs in the signaling field is a means of more thoroughly enlightening the hundreds of superintendents, trainmasters and other officers who have some authority in signaling matters but have not educated themselves up to the point of exercising their authority with the highest wisdom; and a debate should be useful in meeting this need.

These evidences that the personnel of the signal world has made important advances are, indeed, the most interesting feature of the present situation. On the narrow question of the exact present status of the art, such evidence would perhaps not appeal to a court at all; but on the question of the tendency of the art and of how much alive it is, it is significant. However, the signal experts have not confined themselves to thinking, or to thinking and talking; they do things. In interlocking, the all-electric apparatus is becoming more and more common, and the installation of old forms of apparatus because of lack of confidence in the new is not so much heard of. The use of the "upper quadrant" semaphores at Philadelphia, Washington and other places seems to have removed all distrust of the novelty, and nobody is longer afraid of it. The New York Central and the Boston & Albany, we understand, are to adopt for their new interlockings not only the upward inclination but the whole "comprehensive scheme" of the signal association, which means, no doubt, the early adoption of the scheme throughout the New York Central lines; for in interlocking, the change from old to new is neither very expensive nor at all revolutionary. As Mr. Rudd of the Pennsylvania is one of the originators of the scheme, we may expect before long to see that road also signaling "up in the air" everywhere, and with the two biggest trunk lines leading the movement, with their 23,000 miles of line, there will be no question as to their having a following.

In automatic block signaling also, the New York Central seems to be taking advanced ground, and we may soon expect

to see its costly "controlled manual" apparatus going out of use. Indeed, it seems inevitable that this change will be forced on the company, for its block sections at present are two and three miles long. The growth of traffic will necessitate shortening these to one mile, or less, and it is hardly supposable, in the face of the excellent records which automatic signals are now making, that the company will double its force of signalmen for the sake of maintaining the manual system.

This element—the cost of employing signalmen—will undoubtedly force the adoption of automatic signals on all of the busiest roads sooner or later, almost without exception. But roads less busy also find for automatics an increased field of usefulness, as is seen in the action of the Southern Pacific, the Rock Island, and the St. Louis & San Francisco; and the use of automatics in place of interlocking at junctions, as illustrated in our issue of February 19, has interesting possibilities. Possibilities of economy and simplicity are also evident in the "light" signals in use in tunnels on the Long Island and the New York Central, and the semaphore may have to look out for its laurels even in daylight. The installation on the Long Island road, described in this paper February 12, gives promise of a very general amelioration of the troubles connected with insulated joints, and other improvements, made or forthcoming, seem likely to reduce somewhat the enormous expense of signaling on electric roads. The use of the controlled manual by the Burlington on single track without time-tables or "train orders," and the abolition of time-tables on a thousand miles of single track on the Northern Pacific indicate that at last the superintendents as well as the signal engineers are advancing the art of signaling.

It is not necessary to go more deeply into the subject to make clear that the art of signaling is in competent and enterprising hands, but there is still a great deal of territory to be conquered. Orders for hundreds of miles of block signaling make cheerful reading, but the need is for thousands of miles Interlocking, as well as block signaling, lags. The construction of new interlocking plants has not been checked by dull business so badly as have some other lines of railway enterprise, but this department ought to be much *more* active than almost any other. Even the advertising agents ought to put their shoulders to the wheel in this matter, so as to aid in doing away with the discreditable anachronism of having the fastest trains making dead stops at unsignaled crossings.

But is the art of railroading making progress commensurate with that in the art of signaling? One of our best railways has lately had a disastrous and ominous rear collision of passenger trains because good signals did not receive good attention from the engineman and fireman; and a still worse collision occurred on another important road, which ought to be one of the best, but whose managers appear to have been utterly oblivious to the virtues of the space interval principle—not a block signal on the whole road. If prominent companies persistently postpone the introduction of the block system, the public will surely try to punish them in some way—and legislative punishments are likely to hit innocent and guilty alike. Moreover, the public is not so unskilful at punishing as it once was. If our boasted surprise checking does not produce "results," and collisions continue to occur even with good signals and good men, the public will feel confirmed in its belief that machines are better than men, and will require automatic stops. The fact that on the ordinary railway doing a miscellaneous business the use of automatic stops will introduce new troubles, is not likely to affect the lawmakers very much when they are told of specific cases where the apparatus would have saved a score or two of lives.

The advocate of automatic stops may not always have all of the conservatives solidly arrayed against him. The automatic stop and the cab signal are twin brothers, and they help each other; and the cab signals on the Great Western of England seem now to enjoy the hearty though unofficial favor of the conservative Board of Trade. These signals have given such a good account of themselves that Colonel Yorke, the chief inspector of the board, seems willing to have their use indefinitely extended; and if cab signals find favor generally the automatic train stop propaganda will get some of the benefit of it. Willing or unwilling, government functionaries, whether in England or America, will be forced to give favorable consideration to automatic apparatus after it has made a few fortunate records, for one positive example, which everybody can comprehend will outweigh thousands of cases of good results from the old plan of depending on the engineman; for to the popular mind these latter seem negative.

NEW RAILWAY BUILDING.

The fifteenth regular Construction Record of the *Railroad Age Gazette* appears in this issue. The endeavor has been to present a brief but complete record of existing railway construction. The material has been carefully compiled from our own current construction items, supplemented by official information given us by the engineering departments of the railways. In this record we have been conservative, including only such work as we know to be actually under way, or—as in cases of new projects—only those for which surveys have been made, or which we have reason to suppose will be carried through. Those larger railways, on which work is projected but not actually under way, have also been included, as the projected work is an important indication of future expansion.

This record actually shows a much larger amount of work under way than did the record of last year. During that time, one of forced economies, there was a large amount of partly completed work, actual construction of which was held up as a result of the financial situation. The work then under way, in most cases, and especially in those where it was of great magnitude, was being done by those companies which had sufficient funds in hand to carry on the improvements and the work then under way. A comparison of the records of the Pennsylvania for 1908 and 1909 indicates that there was no substantial cessation during the past year of the work projected or under way in 1908. The Southern Pacific record for 1908 showed work actually under way on six of its subsidiary lines, while the present record shows the same condition on nine lines. This comparison, however, does not reflect the condition which existed throughout the year, as the work which was reported under way in March of last year was later suspended and has been resumed within the past few months. The same condition applies in a number of cases, and the construction records of any two years can, at their best, only be compared as indicating activity at the particular time. The Annual Construction and Annual Mileage records differ very materially in this respect, the one showing activity at a particular time and the other progress. It is noticeable throughout this record for the United States, that the words "work under way" have replaced those of "work temporarily suspended" in the record of last year.

There is at the present time great activity in Canada, both in work under way and new projects, the very large number of the latter having been presented to Canadian Parliament within the past two months. Progress during the year has not met the hopes and expectations of the country, although there was no cessation of work, as was the case in the United States. Of the portion of the Grand Trunk Pacific being built by the Canadian government under the name of the National Transcontinental, the line from Winnipeg, east to Lake Superior Junction will very probably be completed during the year, as well as the Grand Trunk Pacific connection from Fort William to Lake Superior Junction. On the Canadian Pacific, work is now under way on about 375 miles, including extensions and double tracking. On the Canadian Northern, including the lines in Ontario and Quebec, work is under way on about 550 miles with surveys made on as many miles additional.

In Mexico, on the lines of the Southern Pacific Company, concessions for rebuilding the Sonora Railway, from Nogales,

Ariz., south to Guaymas, 265 miles, have been granted; work is under way on the Cananea, Yaqui River & Pacific at the several openings from Guaymas south to Guadalajara and it is expected that the line will be operating within three years.

CHANGING TENDENCIES IN RAILWAY LOCATION.

The paper in another column, describing the Carolina, Clinchfield & Ohio, gives an excellent example of the attitude that engineers and investors have grown into during the past few years. Curiously enough, it is an approach to the attitude assumed by some of the opponents of railway building in the early days, who, arguing from the standpoint of the canal, maintained that a railway to be efficient must be destitute of grades and curves. While the builder of to-day does not go quite to the point of the complete elimination of these necessary evils of the road, an attempt is made to approach that degree as closely as possible, and it is common practice to place very definite limits within which the locating engineer must keep his profile and alinement when he is sent into the field. Naturally these limits vary with the topography of the country, and they are apt to be crowded to the last notch of present possibilities. Of course it would be possible to locate a line between any two points that would run on a uniform grade and be perfectly straight, but it would be necessary in most places to do as was suggested, when a similar possibility was pointed out for a West Virginia location, to stay in the air or under ground all the time.

Next comes the lines that are building, or have been built, where the location is the best available with the present means of construction, and we must bear in mind that a location which we consider admirable to-day as affording the best possible route for economical operation, may be among the obsolete impossibilities of fifty years hence. To name names and cite cases, it is probable that the Berkshire division of the New Haven, from Bridgeport north, was regarded as a fine piece of location when it was built. It has about the same grades as the local fall of the river which it follows, and it twists and turns and clings close to the bank throughout almost its whole length. It is a case of very light side-hill cut and cast that could be done with the pick and shovel and barrow, which were the available tools of the time. Dynamite was unknown and the steam shovel had not been dreamed of.

Contrast this with two other locations recently made: the Virginian and the Clinchfield. One runs from the coal fields of West Virginia to the sea with only one grade—that over the Alleghanies—that exceeds the fixed 0.2 per cent., while the other is located across the highest and heaviest part of the Blue Ridge on a 0.5 per cent.

These contrasts show two things: first, that the facilities of construction have increased to a marvelous extent, else these new roads could not have been built at all; and, secondly, that operators and owners are looking much further into the future than they did and are incurring the tremendous expense involved in low grades and easy curves, not to save money in first cost but in the years of operation that are to follow. And it is this same spirit that has led, on some roads, to the recent practical abandonment of old locations and to spending millions in the elimination of curves and grades—work which literally amounts, in some cases, to staying under ground or in the air for long distances.

The result, or the cause, as you please, of this, is that while the demands made upon the locating engineer are more severe than they have ever been before, he is allowed a greater latitude in the matter of expense. In fact, the whole method has been changed.

To revert to the former comparison, it is probable that the old Housatonic Railroad was located on the first line run and that reconnaissance was quite as limited. It was a case of putting down a line that could be operated, and putting it down at low cost through a comparatively easy country. At the time, the railway surveys were the only ones in existence.

This is in sharp contrast with the methods of the Virginian and Clinchfield. To start with, each had the benefit of the magnificent topographical maps of the United States Geological Survey. With these, a careful and comprehensive study of the country could be made and routes marked out over which a promising preliminary could be run, and it was even possible, at times, to make a rough estimate of quantities before a party was sent into the field. Then, when this was done, instead of adhering to a single or to a few parallel preliminaries, the whole wide belt of possible territory was run in. This covered practically the whole width of a state in some cases, and instead of deviations to touch large towns and traffic centers, they were ignored and the whole effort concentrated on getting the shortest line between terminals that could be kept within the prescribed limits of grade and curves. It would be rash to say, in any case, that the best possible location has been obtained, but it is at least within reason to say that it would be difficult to find a better.

All this involves fine instrument work, and we have had so much of it that we have come to expect tunnel headings to meet without a perceptible offset, and a spiral approach to every curve is a foregone conclusion. But it is interesting to note in this connection what emphasis and importance the engineers who have had to do with this work place upon the eye of the locating engineer. The man who can grasp the possibilities of a country and who, on what is little more than a reconnaissance can point out the way that is to be finally adopted, is the man upon whom these low-grade lines depend. Consequently, more and more importance is being attached to the reconnaissance.

In all this, methods are being constantly improved and, while there is frequently no begrudging necessary expenses, the field party is expected to work with great rapidity and accuracy. For such work as this in a rough country it is respectfully suggested that some engineer will soon startle his fellows by making his reconnaissance in the car of a dirigible balloon! This suggestion is really not very chimerical, and any man who has attempted to gather in a clear idea of the topography of a mountain country like that covered by the Appalachian range, by climbing trees on high summits will appreciate the value of a vehicle that can lift him above everything and let him see like a bird what lies below and what he has to contend with. Not only can a general topographical impression be obtained at a glance, but it can be photographed and retained; and then barometric readings at landings or on the faces of cliffs will convey some advance idea of what the preliminaries should be depended upon to check. In this way the reconnaissance, instead of being a hasty examination of a belt of country that is "essentially very rough and rapid," may be raised into the category of the operations that are ranked as painstaking and accurate, and will enable the engineer to be sure that he is making no mistake when he decides that one route is distinctly superior to another.

It is work such as that recently done that marks the advance in field work and sets the pace for that which is to follow. That the pace will be an ever quickening one and increasingly strenuous, we cannot doubt, but to just what point it will ultimately bring us it is impossible to tell.

The steam shovel, the air drill and dynamite have made locations possible that would have been out of the question with pick, barrow, hand drill and blasting powder. So, even now, we hear rumors of tunneling machines that are to bore the rock as the auger does the wood, and of conveyors that will do for a cut and fill what they are already doing for coal and grain. If these things come true, we may find that location will be cut to lower limits of grade and curve, and the roads approach more nearly still to the old ideal of their opponents. At any rate, it is well to consider occasionally what is demanded, and how managers and builders are coming to realize more and more clearly every year, that low grade and easy curves are an indispensable condition in the location of a railway that is to be successful under the stress of modern competition. Unless these conditions are fulfilled, what might

otherwise be a paying property is pretty sure to be a failure. Yet it requires a bold prophet to lay out a railway like the Virginian, on a location almost devoid of traffic points between the bituminous coal and the sea, while the expenditures to get a low grade entail a heavy perpetual charge on earnings. The results of these economic experiments are going to be interesting landmarks in the railway history of the next decade.

NEW RAIL ORDERS AND SPECIFICATIONS.

The orders given for heavy rails in recent months have been sufficient to start the large mills. The new specifications indicate that the deadlock between manufacturers and railways has been broken, and there is a general feeling of satisfaction among them over the prospect of a supply of much better rails than have been rolled in the past few years. The agitation brought about by numerous rail failures and rapid wear has been productive of good to both interests. The dull period following the panic served to make steel manufacturers less independent, and it allowed ample time for a thorough investigation of the subject by the railways.

Probably never was a technical subject connected with railway construction and operation more thoroughly discussed by such a large number of prominent experts. As a result of this, the rail sections have been changed, methods of manufacture have been greatly improved, and the whole business of making, inspecting and purchasing rails has been placed on a more satisfactory basis. It will be interesting, therefore, to notice the principal changes which have been made in rail sections and rail specifications. The sections now used by several large lines, which may be regarded as representative of the new practice, are illustrated on another page of this issue.

The new specifications for rails issued by the larger lines include chemical requirements for open hearth rails, and the orders are usually for as large a tonnage of this grade of steel as the mills are prepared to supply within the time limits. The growth of the open hearth rail manufacture in the United States has been rapid. In 1903 only 45,000 tons were rolled. In 1907 the amount rolled had increased to 252,000 tons and in 1908 to 567,000 tons. The Bessemer rail production reached its maximum in 1907 when 3,380,000 tons were rolled, while in 1908 it was the smallest since 1897, less than the average for the ten preceding years, and only 1,354,000 tons. The open hearth rails rolled in 1908 equaled 42 per cent. of the Bessemer. The present capacity of the steel works in the United States for the manufacture of open hearth rails, including the new Indiana Steel Works just going into operation, is nearly 2,000,000 tons, or about 50 per cent. of total new rail requirements in prosperous years.

The new Pennsylvania specification makes no change in the chemistry for Bessemer rails, but adds a second classification in the chemistry of open hearth rails. The previous specification of April, 1908, made 0.03 phosphorus and 0.80 carbon the upper limits, while the new one makes the upper limits for Classification A, phosphorus 0.03 and carbon .083; for Classification B, 0.04 phosphorus and 0.75 carbon. The desired carbon for the two grades is 0.75 for the lower phosphorus, and 0.70 for the higher, thus following the general law that for each 1/100 per cent. phosphorus added the carbon should be reduced 5/100 per cent. on account of the brittleness due to excessive carbon and phosphorus. The reason for making two classifications for open hearth rails relates principally to the cost of manufacture. It was thought desirable to specify phosphorus as low as 0.03 so that high carbon could be used and the wearing quality of the rails, particularly on curves, would be materially improved. But the extra time required in the open hearth furnace to reduce phosphorus from 0.04 to 0.03 results in some increase in the cost of manufacture, and a slight addition to normal price per ton is added for the Class A rails.

A clause has been added which excludes ingots that have been so overheated that the scale on the sides becomes liquid.

The requirements under the drop test are less rigid than those of the previous specification and some concession has been made to the manufacturer in this particular which is not likely to insure better rails so far as the brittleness of Bessemer rails is concerned. The former requirement was that "if a test piece breaks under the drop without showing physical defects all rails made from that heat shall be rejected absolutely." The present provision permits of a retest after failure of the first, allowing two more pieces from the same heat to be tested, and if neither of these fails the rails are accepted as No. 1 or No. 2, according to the deflection. If either of the second test pieces fail all rails from that heat will be rejected. The provision that drop testing shall be continued to the destruction of the specimen in case the first piece breaks without showing physical defects, is an added precaution which should result in a material benefit to the railway by reducing the number of piped rails which, in spite of the usual inspection and tests, get into the main track. This new feature in drop testing has been obtained by some concession to the rail maker, as it is agreed that if the test piece does not break under ordinary conditions, but when nicked and tested shows pipe, the top rail from each ingot will be accepted as "special" rails, and marked differently. These rails will be regarded as inferior and not used in main line track. For open hearth rails it is required that makers shall furnish inspectors with complete chemical analysis for each melt.

The new Baltimore & Ohio specification for Bessemer rails, dated January 25, 1909, is similar to the Pennsylvania in chemical requirements, but for open hearth the chemistry is somewhat different. The upper limit for phosphorus is made 0.04 for all rails made by that process. Manganese is allowed as high as 1.00 per cent. and carbon 0.80 per cent. This specification also allows re-tests. It provides that drop tests shall be made of two test pieces of rail rolled from the top of different ingots and if either fails a third piece shall be tested. The new Pennsylvania Railroad specification requires the drop test pieces to be cut from the rail bar next to either end of the top rail. The Baltimore & Ohio also requires the drop test to be carried to destruction so that an examination can be made of the fracture and pipe or other interior defects can be detected; and acceptance of the rails is based on the clean fracture as well as the amount of deflection. The effort to enforce the discard of a certain per cent. of height of ingot to eliminate segregation appears to have been abandoned and the new specifications now simply require that there shall be sheared from the top of the ingot sufficient discard to insure sound rails.

The Canadian Pacific has prepared a new specification for rails which is interesting because it is intended to meet the severe winter conditions of Canada when the track is frozen rigid for long periods. It was prepared also with special reference to the conditions of rail manufacture in that country. Two rail mills in Canada have a capacity about equal to the ordinary requirements of Canadian railways. The Dominion Iron & Steel Co, at Sidney, N. S., manufactures basic open hearth steel only. The product of the Algoma Steel Co. at Sault Ste. Marie, Ont., is 75 per cent. acid Bessemer and 25 per cent. basic open hearth. The Bessemer rails have only .085 phosphorus and the average carbon is 0.58, and for open hearth steel the upper limit for phosphorus is 0.06 and the lower limit for carbon 0.60. The standard section for new rails on the Canadian Pacific is 85 lbs. and this is preferred to the 100-lb. rail on account of the unfavorable experience due to square breaks with the 100-lb. rail having A. S. C. E. section. This decision is based upon the fact that the 80-lb. A. S. C. E. section, having identical chemical composition under the same traffic and like climatic conditions, did not break as frequently. The Canadian Pacific has in track now 85,000

tons of the new 85-lb. rails. In their manufacture it was found that when they approached the saw they were of more even temperature in all parts of the section, the rail head being cooler than in the old section. Therefore a finer grain of steel was produced, having better wearing qualities. The more equal distribution of material between the head and the base simplified the cold straightening to such an extent that it required 40 per cent. less work than the old section with its thin flange and thick head. The straightening of the rails under the cold press seriously impairs their strength and is one of the principal causes of fracture. If the 100-lb. rail had been given the advantage of a better balanced section it also could have been rolled with a cooler head and would have required less cold straightening and given better service.

The Canadian Pacific drop test for open hearth rails is more severe in most of its provisions than those already mentioned. It requires that from each 50-ton heat three rail butts shall be tested, and each butt must be taken from the top end of the first, middle and last ingots cast of each heat. The supports are 4 ft. apart and the height of drop is 20 ft. for the 85-lb. section. If two of the test pieces are not broken and show a deflection of less than 3¼ in. the heat is accepted. If two fail it is rejected. There are no retests and less is left to chance than is in most of the rail specifications used in the United States. The practice as to discards in Canada also appears to be more definite and satisfactory than in the United States. After cutting off sufficient to square up the end, at least 12 in. more of seemingly solid steel is cut from that end of the bloom, and if the steel does not then look solid the cutting must continue until it does. In the same specification the drop test for Bessemer rails is 18 ft. and the minimum deflection 3¼ in. A rail butt from every third heat is taken from the top end of the first ingot. If it fails a second test is made and if it fails all rails made from that heat are rejected.

The Santa Fe received last year a supply of open hearth rails from the Bethlehem Steel Co., and they were among the first rolled by the new mill. The specification required 0.04 phosphorus and 0.60 carbon. The section is a special one which is a modification of the A. R. A. series A, so as to obtain a weight of 85 lbs. per yard. It is shown in our article on rail sections.

The Burlington has ordered a large tonnage of open hearth steel and adopted the 90-lb. section, Series A, recommended by the American Railway Association. Its specifications requires that there shall be sheared from the end of the bloom formed from the top of the ingot 9 per cent. discard, or until sound metal shows on the end of the sheared section. "The chemical composition shall be within the following limits: Carbon, 0.55 to 0.65; manganese, 0.75 to 1.00; silicon, not to exceed 0.20; phosphorus, not to exceed 0.06. For every point (0.01) phosphorus is reduced below 0.06, carbon may be increased four points (0.04), the maximum carbon to be 0.80." The requirements in the drop test provide that at least two test pieces shall be selected from each heat by the inspector, and the height of drop for the 90-lb. rail is 19 ft. If the first test piece breaks then two others from the same heat are tested and if either of these fail all the rails from that heat are rejected. If both meet the requirements, then the rails from that heat will be accepted. It is also provided that rails shall not vary throughout their entire length more than 5 in. from a straight line in any direction when delivered to the cold straightening press. Those which vary beyond that amount are classed as second quality rails.

Inspectors using the new Pennsylvania rail specifications have discovered quite a large percentage of piping. Testing to destruction discloses such piping even in the tests that had failed to break under the drop, thus clearly indicating that there must have been a very large number of piped rails delivered to the railway companies under former practice. The rail makers have been much disposed to contradict the possibility of a large percentage of piped rails existing; in fact, have in many cases taken the position that undue stress had been placed upon that defect. Some authorities, for instance, have argued that with many failed rails the defects which have been classed as pipes have really been caused by the presence of slag which under the strain of traffic had acted as a wedge splitting the steel. While that may have happened in some cases, many failures causing accidents have been due to pipes, and some method of inspection should be used to detect them.

In conclusion, it is evident that the rail question in general is in an experimental stage, but making satisfactory progress toward improved standards. The new sections with a heavy base having a larger area than the head, have already shown important results in reducing cold straightening and in producing a finer steel structure due to cooler rolling. The open hearth steel, with phosphorus less than half that in Bessemer, will largely reduce rail breakages due to brittleness. The drop tests must be readjusted to suit the testing machine with a standard anvil and definite foundation. The one important matter which remains unsettled and indefinite is that relating to discard, segregation and the other items which affect the structure of the rail by producing pipes and similar imperfections. These will be found as frequently in open hearth rails as in Bessemer, and the best safeguard thus far proposed is testing under the drop to destruction, so that the fracture may be examined. This feature must, therefore, become an important part of a good rail specification even at an extra cost per ton.

Letters to the Editor.

TITLE TO PATENTS VS. TITLE TO LAND.

New York, March 2, 1909.

To the Editor of the Railroad Age Gazette:

Our government, when viewed from a mechanical and engineering point of view, presents some striking defects in construction with a consequent low percentage of efficiency in operation. Although there are a good many poorly designed machines in the government shop, I will direct attention only to those located nearest my corner.

The patent office report for 1908 shows a surplus of $724,544. From experiences I have had in the office, it seems to me that this surplus could be applied advantageously to increasing salaries for the present number of employees, or to adding to their number; preferably the former. This is a case where a few well trained men are better than many green ones. As it is now, the applicant, or his attorney, frequently finds it necessary to educate the examiner in charge, in the most fundamental principles of patent law before allowable claims would be allowed. Not long ago I received an official acknowledgment rejecting one claim with the statement, "Applicant cannot be allowed to multiply claims by adding old elements to previous combinations."

I asked for a review of that action and criticized the statement by saying, "It is my impression that the addition or subtraction of one or more elements to or from a previous combination is just what constitutes the invention, and is the subject of patent," of course, provided the new combination is useful. Two other claims were rejected on Smith & Jones. I have had claims rejected that way before and it took me six months to convince the examiner in charge that the fact that my claims each alone involved structures from both patents cited was just what entitled me to a patent.

We spend large sums each year to tell the farmer maybe it will be raining or clear to-morrow. Many millions are now being spent to reclaim arid lands in the West, and then, when this land has been acquired and made valuable by the expenditure of government money, individuals may acquire per-

petual title by the payment of minor fees as a manifestation of their intention to use the land. But when a person makes an invention, which is the nearest possible approach to making something out of nothing, and is the result of individual effort, a shaky title and rights of ownership are granted only for 17 years. This looks like a blunder in governmental construction. It is illogical, inconsistent and unjust, and the ill effects are becoming more and more apparent.

More substantial encouragement and protection should be extended to inventors. There is not as much reason for perpetual land titles as there is for perpetual patents. I think land titles should be half as long as patents, and that the periods should be about 20 and 40 years, respectively.

OLIN S. PROCTOR.

HIGH RAIL JOINTS AND THE TAMPING HABIT.

Philadelphia, Pa., March 1, 1909.

TO THE EDITOR OF THE RAILROAD AGE GAZETTE:

A recent development on one of the Eastern railways has brought out a rather peculiar phase of track maintenance, which very plainly shows the reason that such large sums are being spent for track labor.

The railway in question was just beginning to use angle bars of the deep girder type, and the peculiar condition to which I wish to refer was brought to the attention of the officers in the form of a complaint. The track foremen made reports that the new bars caused high hard spots at the joints. An investigation of this very unusual complaint proved that the rails were generally high at the ends as reported, and frequently along the middle portions also, and usually low at the quarter points. Some cause acting with well-defined regularity was producing this peculiar effect. Further investigation revealed the cause, and brought to light the feature which is worthy of attention in connection with the present track development. The track men had the joint tamping habit. The deep girder bars were designed to have about the same stiffness as the rail, and therefore, where the bolts were kept tight, required no more tamping at the joints than under the other ties along the rail. The man with the pick had become so accustomed to the practice of skipping along from joint to joint to do his work under the old style angle bars having only one-third as much stiffness as the rail, that the new track naturally received the same habitual tamping as the old, while, at the same time, the ballast under the joint ties of the new track had remained as high and as solid as along the rest of the rail on account of their being no greater deflection at the joint than elsewhere. Consequently these already solid bearings were packed all the tighter, and the hard high places in the track were caused directly by habit rather than by the new type of bars. For the same reason the middle portions of the rails were often high, on account of the extra tamping along the length of the joint ties and under the opposite rail.

The remedy was simple and effective. The tamping was materially reduced, and a revised working method resulted in more evenly distributing the work along the rail. The men were instructed to sight for the low spots, and to raise them wherever they could be detected along the rail, rather than do all the surfacing by automatically skipping from joint to joint. A man with a wrench took the place of a number of pick wielders.

The theory underlying this occurrence is quite apparent, and is so strikingly in accord with an editorial which appeared in the *Railroad Gazette*, April 12, 1907, on "Continuous Rails for Uniform Track Structure," that I would refer your readers again to that able presentation of a theoretical principle which now seems to be well borne out by facts.

Uniformity seems to be the thing most desired in a railway track, and uniform tamping along the rails should serve as a good indicator of such conditions. An upper rail structure having an equal stiffness throughout, together with reasonably uniform drainage and sub-grade conditions, should act to produce the desired end. On the other hand, it is clear that a weak joint which allows excessive deflection of the rail structure will destroy this uniformity under any conditions and will be specially persistent in adding to maintenance troubles where the drainage is not the best. In the latter case a "pumping joint" is the result, and the depth of the holes into which all the surrounding water is drained largely depends upon the stiffness of the joint bars, the tightness of the bolts and the amount of abnormal deflection which the bars permit. All railways cannot be built with stone ballast on nicely elevated banks with efficient ditches along the sides, and we will always have with us the low-lying, marshy districts, where the most aggravated form of the joint tamping disease is contracted. Roads that have heretofore used the old style light angle bars may continue to do so under the increasing loads without any unusual tamping symptoms showing themselves, except in their expense accounts; but in order that the full benefits may be obtained as the new type of deep girder angle bars are being substituted: Look out for the "joint tamping habit."

M'LEOD THOMSON.

Contributed Papers.

RECENT RAIL SECTIONS.

The Pennsylvania has adopted the sections for 85 and 100-lb. rails which were designed and recommended by its rail committee in September, 1907. The 85-lb. section has a head with vertical sides; the width of base is ½ in. less than the height of rail, and the thickness of the base is ⅛ in. greater than that of the A. S. C. E. section. The head of the 100-lb. rail has sloping sides, and the top corners have a $\frac{7}{16}$-in. radius. The thickness of the base averages ⅛ in. larger than the A. S. C. E. section and the width of base is only 5 in., compared with 5¾ in. in the A. S. C. E. section. The width of base is $\frac{1}{16}$ in. less than the height of the rail

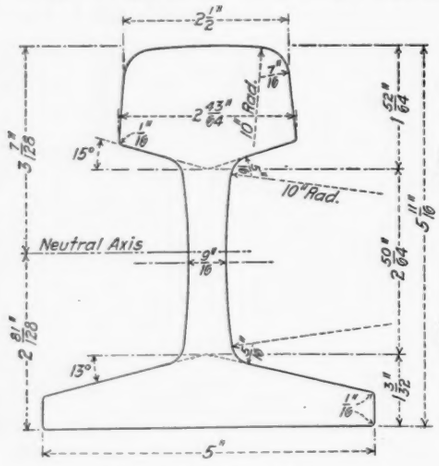
The 90-lb. section adopted by the Burlington is that proposed by the American Railway Association in Series A. This appears to be a compromise section, the thickness of the base being only about $\frac{7}{8}$ in. more than in previous practice. The height of rail is ½ in. greater than the width of base. In this rail the effort to balance the section is carried so far as to make the area of base 3.6 per cent. greater than the head.

The 85-lb. section, adopted by the Canadian Pacific, has the section balanced with 4.2 per cent. greater area in the base than in the head. In the Pennsylvania 85-lb. section the area of the head is 2.2 per cent. greater than that of the base. The Canadian Pacific section has the same height as the Pennsylvania section, 5⅛ in. The reason for limiting the height to this dimension has been explained by Mr. Gutelius of the Canadian Pacific, as follows:

> "When shimming becomes necessary the rails must bend sufficiently to receive their support from the ties, and if the rail is too rigid or too hard it is liable to break. For this reason we deem it wise to limit the height of rail to 5⅛ in. and place the additional strength on those portions which are most likely to crack or break."

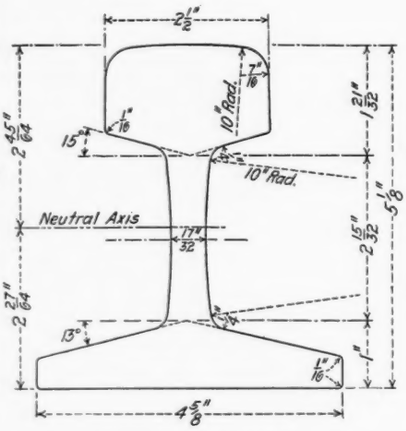
The Canadian Pacific was not satisfied with the A. S. C. E. sections, either 80 or 100 lbs., and their experience with 100-lb. rails had been very unsatisfactory owing to breakage, and the majority of such breakages showed laps or seams near the center of the flanges. The explanation of such mechanical troubles was that they were produced by the necessity of spreading the steel for so wide and thin a flange, and through the peculiar way in which the rolls were designed, this lap was frequently produced, and also that the distribution of the metal of all of the A. S. C. E. sections, and particularly the heavier ones, led to an undue amount of work in the cold straightening.

They were not prepared to adopt the 100-lb. section as their standard one, owing to the greater cost entailed by that weight of rail. Nor did they think the 80-lb. section was quite heavy enough, and therefore they compromised upon an 85-lb. bearing. For a 90-lb. section it is proposed by the chief engineer of this system to use the A. S. C. E. 85-lb. section, with sufficient added to the lower side of the base to secure the proper weight. The present standard splice bars can then be used.



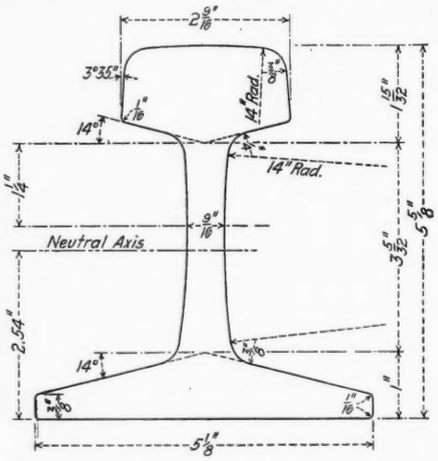
Pennsylvania, 100-lb.

		Per ct.
Area of head	4.09 sq. in.	41.0
" " web	1.85 "	18.6
" " base	4.03 "	40.4
Total	9.97 sq. in.	100.0
Moment of inertia		41.9
Section modulus Head		13.71
Section modulus Base		15.91
Ratio periphery head to area head		1.59
" " web to area web		3.58
" " base to area base		2.43
" total periphery to total area		2.30



Pennsylvania, 85-lb.

		Per ct.
Area of head	3.57 sq. in.	42.2
" " web	1.51 "	17.8
" " base	3.39 "	40.0
Total	8.47 sq. in.	100.0
Moment of inertia		29.1
Section modulus Head		10.77
Section modulus Base		12.02
Ratio periphery head to area head		1.73
" " web to area web		3.81
" " base to area base		2.69
" total periphery to total area		2.48



Burlington, 90-lb.

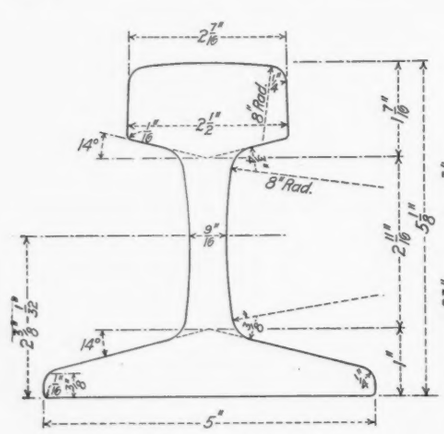
		Per ct.
Area of head	3.20 sq. in.	36.2
" " web	2.12 "	2.40
" " base	3.50 "	39.8
Total	8.82 sq. in.	100.0
Moment of inertia		38.70
Section modulus Head		12.56
Section modulus Base		15.23
Ratio periphery head to area head		1.90
" " web to area web		3.30
" " base to area base		2.63
" total periphery to total area		2.52

one. In designing it, Mr. Gautilius took the exact dimensions of the head of a 75-lb. rail which had given them extremely satisfactory service, and then proportioned the rest of his section to that, making the new section weigh 85 lbs. per yard, and with this new section that they have had satisfactory rolling results.

The 85-lb. section adopted by the Santa Fe for the open hearth rails rolled last year at Bethlehem is a special one and a modification of the A. R. A., Series A. The shape of the head and base and the splice bar angles are similar to the A. R. A. sections. The height of rail is 5⅞ in., and the width of base 4⅛ in. To prevent this narrow base from cutting into soft ties and canting, it is intended to use tie plates at each

The 90-lb. section adopted by the Baltimore & Ohio has the narrow and thick base, which is characteristic of the new styles, and most of its principal dimensions are expressed in 64th inches. It is similar to the A. R. A. proposed standard Series B.

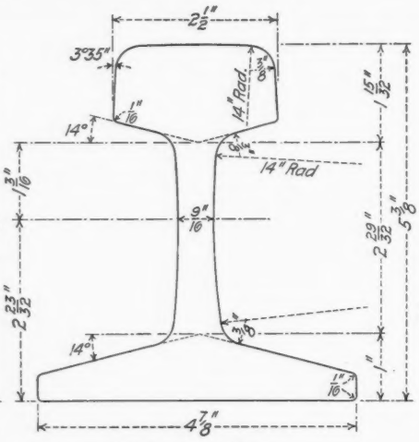
A large power station is being built to supply electricity to Tokio, Yokohama and other Japanese cities. The six 3-phase, 25-cycle generators are direct coupled to vertical water wheels, driven by a 600-ft. head of water on the Oi river. The current will be transmitted 105 miles at 6,600 volts pressure. The line will be carried on steel towers 50 ft. high and 450 ft. apart.



Canadian Pacific, 85-lb.

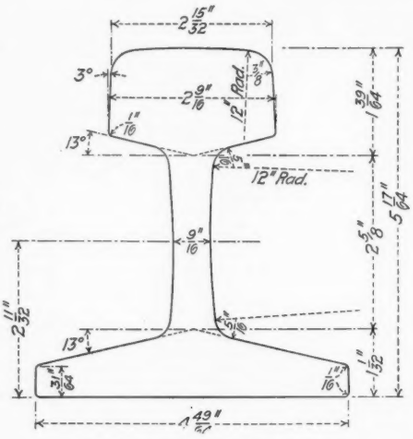
Vertical inertia, 29.492. Horizontal inertia, 7.139

	Percentage Area.	Percentage Cooling.	Sec. modulus Vertical.	Sec. modulus Horizt'l
Head	36.77	1.965	10.425	.....
Web	22.21	3.081	.....	.....
Base	41.02	2.875	12.84	2.855
Total	100.00	2.586	.....	.....



Santa Fe, 85-lb.

		Per ct.
Head	3.09 sq. in.	37.01
Web	1.90 "	22.75
Flange	3.36 "	40.24
Total	8.35 sq. in.	100.00



Baltimore & Ohio, 90-lb.

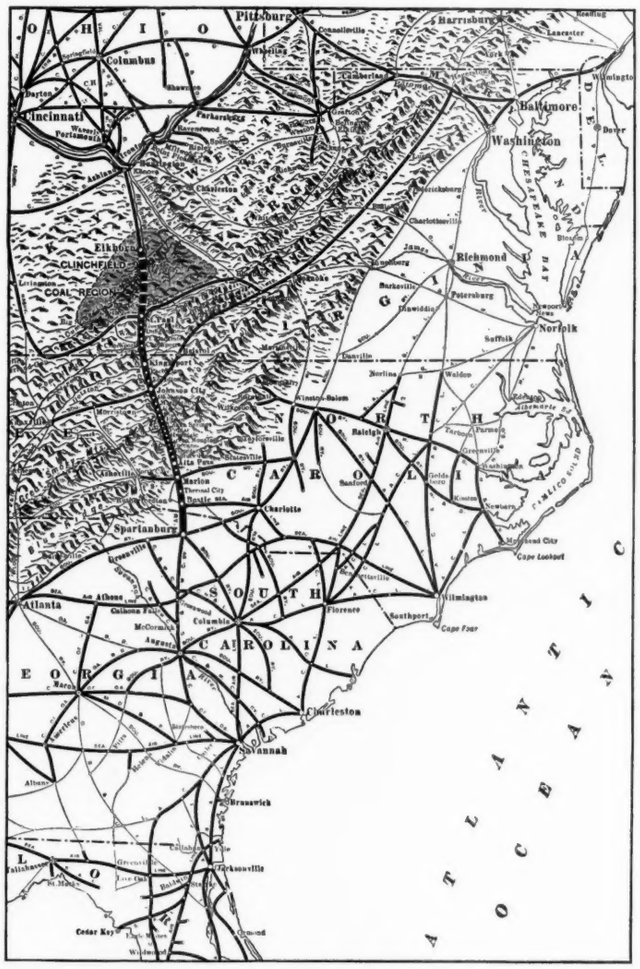
Similar to A. R. A. Series B.

THE CAROLINA, CLINCHFIELD & OHIO RAILWAY.

BY GEORGE L. FOWLER,
Associate Editor of the *Railroad Age Gazette.*

GEOGRAPHICAL AND GEOLOGICAL LOCATION.

It is well-known that the natural barrier to traffic between the plains and rolling country of the West and the comparatively narrow strip of Atlantic coast country of the United States is the great Appalachian chain of mountains extending from the Canadian line nearly to the Gulf, without a single low level break from the northern boundary of Pennsylvania to the Gulf states, a distance of approximately 1,050 miles. The lines of travel and of commerce, following those of least resistance, first went through the low gateway of central New York, and then, as the demand for inter-communication increased, other routes were developed and available passes were occupied by the Baltimore & Ohio, the Pennsylvania, Chesapeake & Ohio, and Norfolk & Western, south of which there was nothing until the Atlanta gateway was reached.



General Location; Carolina, Clinchfield & Ohio.

The Appalachian chain is roughly divided into two mountain ranges, known as the Alleghany and the Blue Ridge, which overlap each other in the general northeast-southwest direction in which they lie, the Alleghany being to the west with the highest points at the northern end of the line and the Blue Ridge to the south. The latter "rises gradually from less than 1,000 ft. in Alabama to more than 6,600 ft. in western North Carolina. From this culminating point they descend to 3,000 ft. in southern Virginia, rise to 4,000 ft. in central Virginia, and again descend to 2,000 ft. on the Maryland-Pennsylvania line." A direct route from Cincinnati and what was the old middle west of Ohio and Indiana, passes over the highest points of the mountains in western North Carolina. As such a route was not open, traffic between these points went east over the Chesapeake & Ohio or Norfolk & Western until it had crossed the mountains, and then turned south over the lines paralleling the range, or dropped down to the west and came by way of Chattanooga, Rome and Atlanta, both roundabout, but presenting an overwhelming advantage because of the low grades existing as compared with the climb that would have to be made on the direct line.

There is another point to be borne in mind in this connection, of vital importance to a complete understanding of the strategic value of the Clinchfield line, which is purely geological. The outcropping rocks of the Appalachian range are divided into two groups by the great Pocahontas fault. The fault was caused by an upheaval of the eastern portion, carrying with it the deposits of the carboniferous epochs. These deposits have since been eroded and have disappeared from the present formations, so that no coal is now found east of a sharply marked line following the northeast-southwest direction of the mountains from Pennsylvania to Alabama, and it is over or around all of this eastern group that the coal of the western fields must be carried in order to reach the markets of the Carolinas and Georgia. The result is that the coal fields of southwestern Virginia and eastern Tennessee though physically nearest the markets referred to, have really been among the most remote commercially because of the roundabout line of travel that had to be followed to reach them. It is quite natural, therefore, that a direct through line between the points of supply and demand should long have been earnestly desired by the people of the southeast, to whom it meant a supply of cheaper coal.

The conditions of modern transportation, however, are such that a route, even though short, cannot compete with the older and longer ones if it is hampered by heavy grades and the lighter train loads that go with such conditions, for the whole basis of economy lies in handling heavy units. So it follows that any new and direct route across the Blue Ridge mountains that is to compete with those already in existence must be a low level line. The chief engineer of one of the great railway systems, after a reconnaissance and examination of the topography, recently declared such a line to be impossible. In other words, a railway to meet the demands of modern transportation could not be built across the Blue Ridge mountains on the western boundary of North Carolina.

As already stated, this direct north and south line has long been sought, and the problem has been variously studied and its solution attempted, but, unfortunately for its earlier consummation, the promoters failed to realize the necessity for a concentration of effort at strategical points, as well as the need of a low grade, in order to meet competition and obtain all of the advantages of the modern high burden-bearing equipment and the movement of large units. Consequently even though the ill-fated Charleston, Cincinnati & Chicago, that was organized in 1889 and did a large amount of work, had been pushed across the Blue Ridge to completion it would have failed to have met the specifications set forth because of the high ruling grades. These were 1 per cent. and more without compensation. A comparison on the ground clearly illustrates the difference between the old and new methods of location. It is especially necessary to emphasize this point, and it will be repeatedly referred to. The old method was so to locate the line that it could be built at a minimum cost per mile, using sidehill cutting wherever possible, and following every bend of ravine and ridge. The new method is to substitute tangents for curves and to cut through the ridges and fill or bridge the ravines.

The magnitude of the work involved in the low-grade method can best be appreciated by a study of the topography of the country traversed. The mountain region of the states

crossed by the Blue Ridge is a series of steep slopes, sharp ridges, narrow hollows and valleys and swift mountain streams with very little bottom or tillable ground. This roughness and the general scope of the difficulties presented are shown in the reproduction of the view from Pumpkin Patch mountain, where the ridges and hollows are defined and the location of the narrow thread of the new railway can be seen. This is characteristic of the ruling topography from Dante to Marion.

HISTORY OF THE CLINCHFIELD PROJECT.

After the failure of Baring Bros. and the cessation of work on the Charleston, Cincinnati & Chicago, Geo. L. Carter obtained control of the property as well as that of a small mining road, the Lick Creek & Lake Erie, seven miles long, and started in to develop it into a first-class low-grade line. The first objective point was to secure a line from the coal fields, as the source of traffic, to the markets on the southeast side of the Blue Ridge. The starting point was, therefore, temporarily fixed at Dante, Virginia, the present seat of the Clinchfield Coal Corporation, to which reference will be made again, but with final objective point at Elkhorn City, Ky., the terminus of the Big Sandy division of the Chesapeake & Ohio Railway.

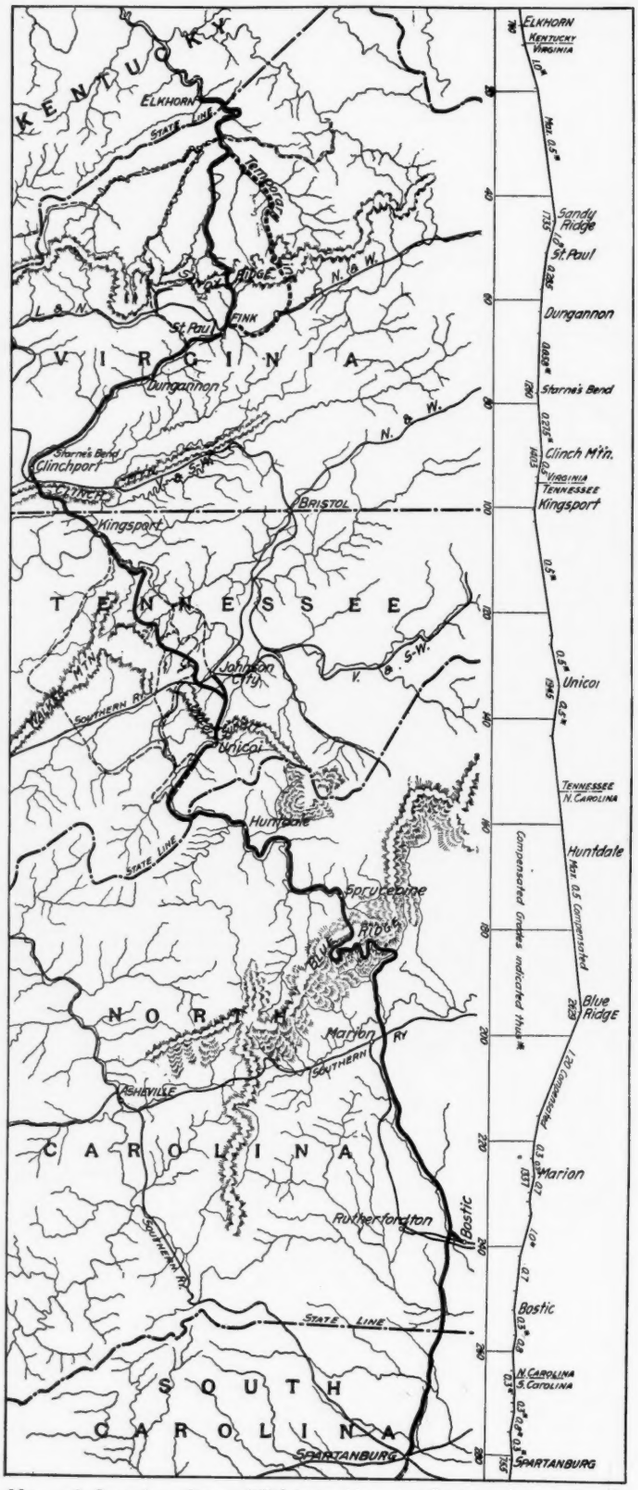
Dante is located at the head of Lick creek, about six miles from Fink, on the Clinch Valley division of the Norfolk & Western. The valley here splits into three hollows which are true cul-de-sacs, and in which the first of the coal operations are located. The elevation is about 1,750 ft. above tidewater. It is in this valley that the old Lick Creek road was located, and which is now occupied by the northern end of the completed Clinchfield road. Here the work done has been that of easing the original profile and alinement, straightening the channel of the creek, and building an assembling yard. The work would be considered heavy were it not for the much heavier work to follow.

LOCATION.

From Fink to St. Paul the line follows the Norfolk & Western Railway and then crosses it and the Clinch river to follow down that stream for 37 miles. Along the upper reaches of this river the road follows down on the surveys of the C., C. & C., but instead of hugging the bank closely and scraping out a side cut it plunges through the ridges and fills the ravines. It is especially to be noted that in building this line, the policy pursued has been to use fills for the ravines, rather than to span them with a viaduct, by means of which construction future maintenance charges will be greatly decreased. This holds for the whole length of the line, and the steel viaduct has been used only where there was some local reason for not putting in a fill. So down through the upper part of the Clinch valley where the topography is very rugged, we find fills and cuts requiring the removal of large quantities of rock and earth, mostly the former, running up to 22,000 cu. yds., while those of from 2,000 to 3,000 cu. yds. are of common occurrence. The grade on this section of the line is favorable to traffic, with only a few grades against loaded movement, having a maximum of .275 per cent., although the country abounds in ridges that rise abruptly from the river.

After passing Guest river, 14 miles from Dante, the valley widens, the bottom lands are fertile and rolling, but the necessity for heavy work continues, if a good alinement and a steady descent is to be obtained. Here the cuts and fills are not always very high, though at times they rise to between 50 ft. and 60 ft., with quantities pressing close on 30,000 cu. yds. The grade varies from level to 0.30 per cent. favorable to southbound traffic, and this continues on to milepost 78, or 33 miles from Dante, where the road crosses back to the left or east bank of the Clinch river. This stretch of valley widens in places to from 1 to 3 miles and is bounded on either side by steep hills. Then, at the lower portion, the hills gradually approach the river on each side culminating in a long cliff on the left bank just below the crossing.

Here for a distance of about 10 miles to Speer's ferry we find some of the heaviest work on the road. This bank of the river is formed by almost vertical cliffs of a hard sedimentary rock and the location required the cutting of a shelf on the side of the cliff for nearly the whole distance, the character of which can be seen in the illustration of the cut near Clinchport. The cost of this work was proportionately high, running at about $180,000 per mile. The ruggedness of this territory is illustrated by the twin tunnels where two ridges



Map of Country from Elkhorn, Ky., to Spartanburg, S. C.

View from Pumpkin Patch Mountain, Showing Character of Country and Track of the Carolina, Clinchfield & Ohio.

come down to the river each of which had to be tunneled and yet their facing portals were only 200 ft. apart. The reason for crossing the river and running through such heavy working was to start well back for the climb to the tunnel through the Clinch mountains. So while there is a slight ascent before reaching the Clinch river bridge, it is at that point that the real ascent starts. The elevation is 1,265 ft. at the bridge and from that on the adverse grade varies from 0.12 to .275 to Speer's ferry and the quantities rise to 230,000 yds. for some of the fills and from 30,000 to 35,000 for the cuts with no small quantities and all rock. The extreme case is found in the Gate Branch fill which is 135 ft. high and contains 300,000 cu. yds. For some of these fills extensive borrowing was required as in the case of the Doe Branch fill, shown in the illustration. This fill is 125 ft. high and required about 250,000 cu. yds. for its formation, in spite of the fact that it was flanked at each end by rock cuts 60 ft. and 65 ft. high, respectively.

Near the end of this part of the line is Copper creek viaduct,

90-ft. Solid Rock Cut on East Bank of Clinch River, Near Clinchport, Va.

1,090 ft. long and 168 ft. high, which would have been made a fill had it not been for special local conditions.

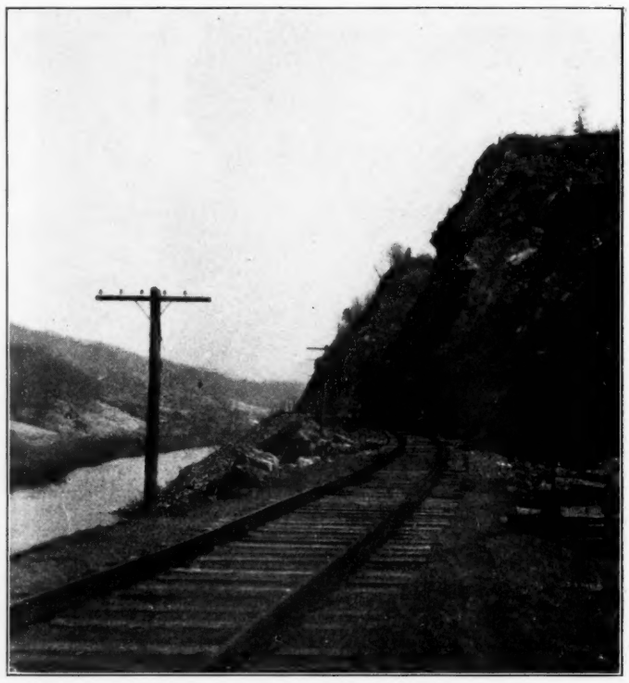
For the past few miles described the road has been approaching the Clinch mountain range on a diagonal line. At Speer's ferry it turns abruptly toward it and into a tunnel through it.

At the bridge over Troublesome creek at Speer's ferry the road has reached an elevation of 1,380 ft. and immediately thereafter plunges into the Clinch mountain tunnel, 4,100 ft. long. This tunnel presented some exceedingly great difficulties to excavation because of the character of the rock. Of all the formations in this region that of the Clinch mountain synclinal is the most resistant. Entering the tunnel from the north there was first a thickness of 2,100 ft. of Sevier shale;

then 400 ft. of Bays sandstone; 530 ft. of Clinch sandstone; 40 ft. of Rockwood formation, and 1,030 ft. of Chattanooga black shale. Geologically these rocks, with one exception, belong to the Silurian epoch and some of them are exceedingly hard. The Sevier shale is a calcareous and sandy shale, with thin beds of impure limestone; the Bays sandstone is a red sandstone and sandy shale; Clinch sandstone is an exceedingly hard coarse white sandstone; the Rockwood formation is a sandy shale and ferruginous sandstone, and the Chattanooga black shale a carboniferous shale. Of all these, the Clinch sandstone offered the greatest difficulty because of its hardness. In one case, the contractors were 72 hours drilling a 6 ft. round of holes, while in one month the heading was advanced less than 60 ft. Timbering was found to be unnecessary and was soon abandoned, and the concrete lining will be put in direct.

After leaving this tunnel the road crosses to Big Poor summit on a rising 0.256 per cent. grade and passes that point through a 62,000-cu. yd. cut. Then comes a long easy descent on grades of from .38 to .50 per cent., across a succession of ridges involving a constant change from cut to fill and fill to cut. Some of this work has a depth of 75 ft. along Opossum creek and the North Fork of the Holston river. The road then goes down the main stream of the same name with no change in the magnitude of the work, the cuts rising to a yardage of 120,000, and this through a valley of good bottom land with fertile cross valleys on either side. This holds to milepost 100½ where there is a change of grade and the maximum of half of one per cent. is used at intervals to the summit at Soldiers' Home and near Johnson City, though much of it is below .40 per cent. Immediately after crossing the Holston river the country becomes heavy again and the hills rise from 300 to 400 ft. on each side of the line, involving heavy cuts and fills, that at Soldiers' Home having a yardage of 268,000. Not only was this cut a heavy one, but some of the material removed was almost worthless for filling. It was known as loblolly mud, a soft, sticky clay that flows out to a slope of nearly or quite 2 to 1 before it will stand.

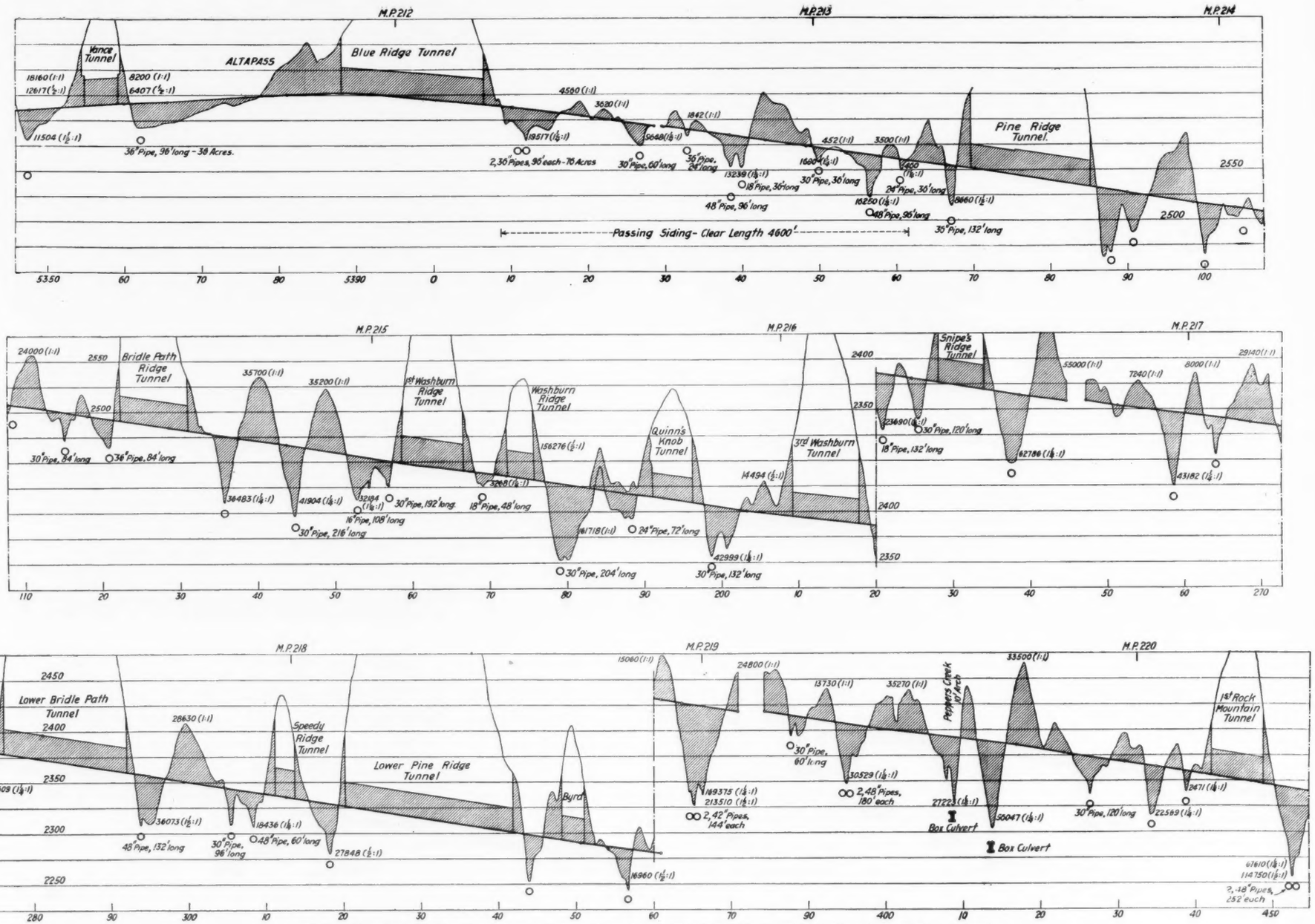
At Johnson City there is a projecting bluff of Cherokee



Shelf in Rock on Banks of the Clinch River.

Fill Over Doe Branch, 125 ft. Deep at Center. Contains About 250,000 cu. yds.

The tracks used by the contractor in obtaining borrow from the solid rock are shown in the left of the photograph.



Three Characteristic Sections of the Carolina, Clinchfield & Ohio; Showing Cuts and Fills.

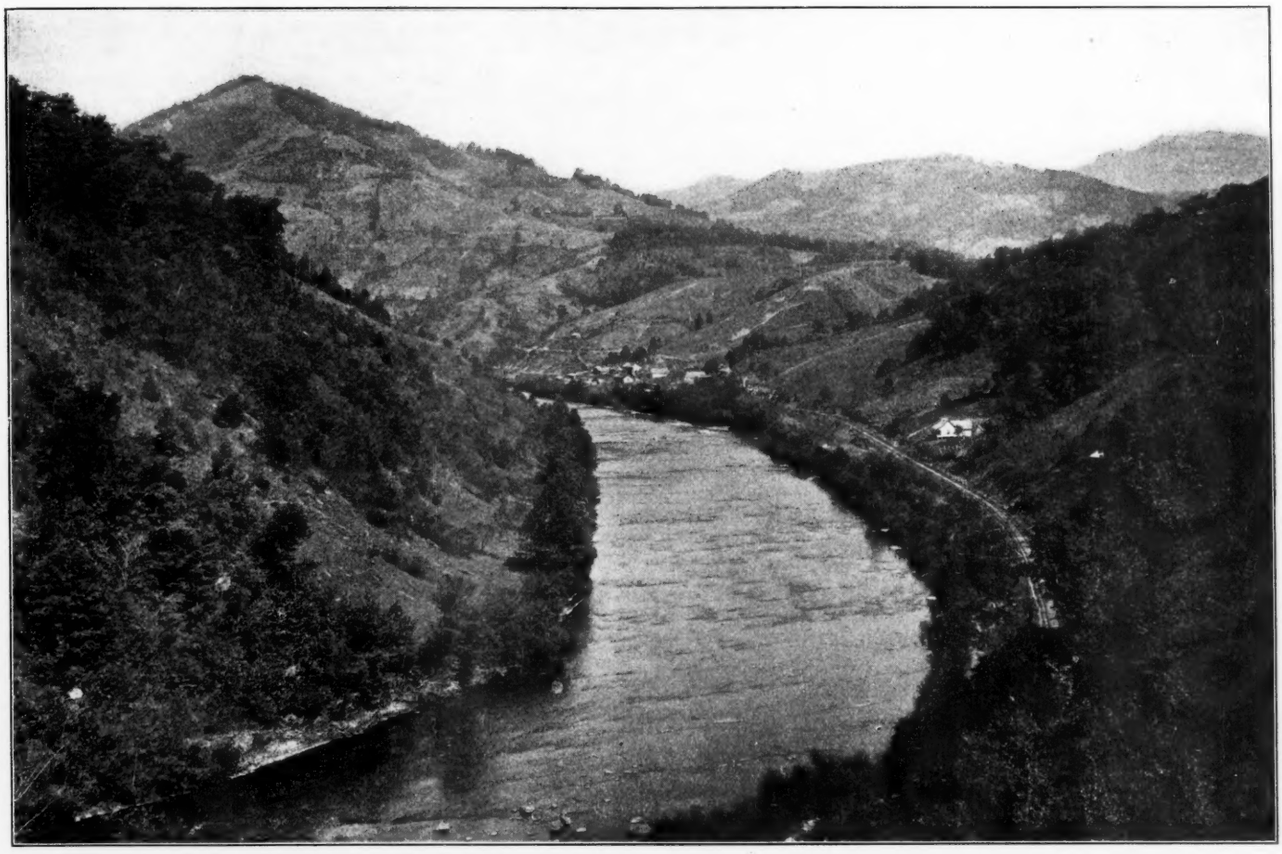
mountain which with Buffalo mountain rises to 2,500 ft. The road skirts these hills and rises to Unicoi summit and then drops down to a level spot, Erwin, on the Nolichucky river, 16 miles from Johnson city. This place will be made a division terminal, and the main shops of the road will be located there. It is one of the few widenings of the valley that occur.

The line then soon crosses the Nolichucky and entering a gorge cut by it through the mountains, starts seriously on its climb to the summit of the Blue Ridge. The character of the country is best described by reference to the accompanying photographs. For 8 miles the roadway is again almost literally carved out of the face of the cliffs and the rock yardages are computed by the thousands. The cliffs rise on either side of the stream to from 2,000 ft. to 2,500 ft., which is from 200 ft. to 600 ft. above the road, while in some places the cut amounts to 110 ft. in height, while back of this the mountains rise to 2,500 ft. above the stream. Beyond this the valley of the Nolichucky widens a little, changing its name to the Toe river at the state line, but for the whole distance to the summit tunnel at McKinney's Pass there are the same steep high hills with projecting ridges and deep, narrow, retreating hollows necessitating cut after cut and fill upon fill, nearly all in rock. The material is softer than that encountered north of Johnson City, along the Clinch river, or in the mountain of the same name. Much of it is a mica schist, or a quartz schistose rock that breaks easily and is quickly penetrated by a drill. In fact, there are large mica deposits along this portion of the line. At one place there is a mica quarry where sheets of clear whiteness a foot square or more are obtained. Where clay is encountered it is soft and greasy to the touch with the contained mica, and is quite unsuited to standing in fills at a sharp angle, but will slide out to a 2 to 1 slope, thus greatly increasing the required quantities above those that would ordinarily suffice. The work is, therefore, heavy for the whole distance, and it required the removal of 540,000 cu. yds. of material in the 39 miles between the north end of the gorge of the Nolichucky and the summit of the Blue Ridge at the west portal of the McKinney Pass tunnel. This was done to obtain a maximum ruling grade of .5 per cent. compensated with a maximum curvature of 6 deg.

The summit reached and passed in a tunnel 1,850 ft. long, there follows the spectacular descent down the eastern slope on a 1.2 per cent. grade compensated and over the seven-legged loop shown in the illustration. As the road leaves the summit it drops down the side of a spur running out from the side of the valley, to its end and then makes a complete turn around the end and comes back to a point 1,800 ft. away from the start, horizontally and about 440 ft. below, after a run of 7 miles. Referring to the plan of this portion of the loop it will be seen that the tunnels on the two legs are opposite each other with the lower one the longer. This is because they are both driven through the same side spur, one higher up and shorter than the other, because the two sides are nearer the ridge and closer together. At the neck, near the swell at the end of the loop, the tracks are only 200 ft. apart horizontally and yet the distance by the rails is about 2 miles. A part of this track is shown in the corner of the first loop. The upper grading in the background is a contractor's road and not the main line.

In the Gorge of the Nolichucky River.

The topography is indicated to an extent by the tunnels, on this descent. These are always through spurs projecting from the sides of the mountain. The work here, while heavy, is not on the gigantic scale of that which has preceded, and after a run of 21 miles in which the air line distance traveled is 4.09 miles, the road, at milepost 233, is running along the banks of the North fork of the Catawba on the Atlantic drainage, 1,434



Pumpkin Patch Mountain at Toecane, N. C.

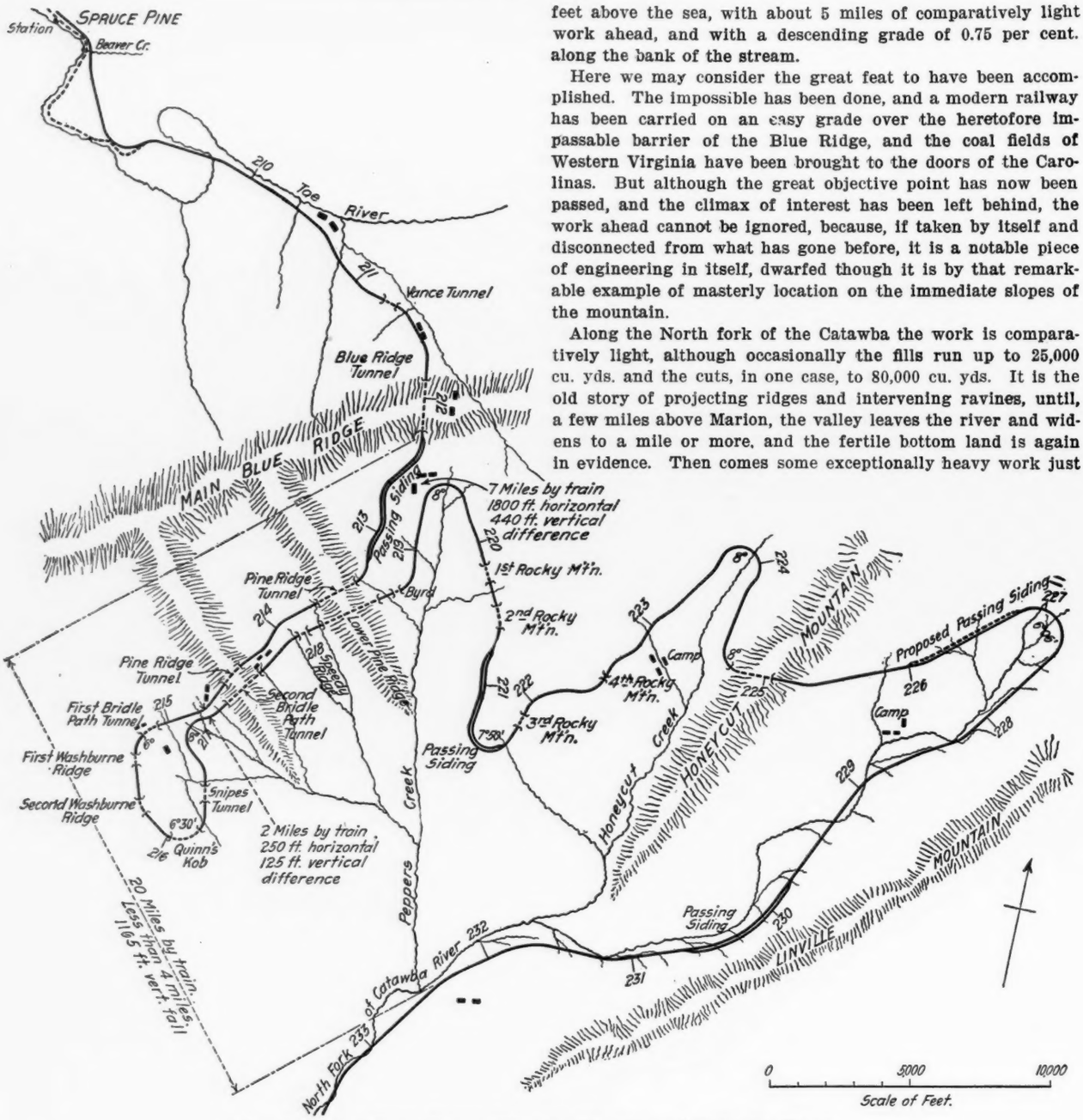
On the Blue Ridge at the Corner of the First Loop.

Actual distance from viewpoint to lower track, 250 ft. Distance by rail, 2 miles. Difference of elevation, 125 ft. The roadway in rear of compressor plant is that used by the Shay geared locomotive in delivering supplies over the mountain during construction.

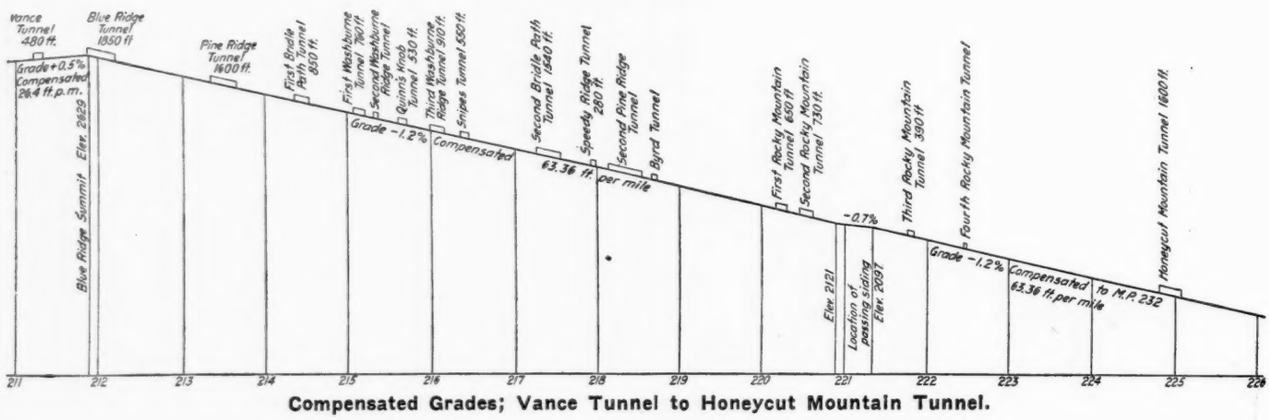
feet above the sea, with about 5 miles of comparatively light work ahead, and with a descending grade of 0.75 per cent. along the bank of the stream.

Here we may consider the great feat to have been accomplished. The impossible has been done, and a modern railway has been carried on an easy grade over the heretofore impassable barrier of the Blue Ridge, and the coal fields of Western Virginia have been brought to the doors of the Carolinas. But although the great objective point has now been passed, and the climax of interest has been left behind, the work ahead cannot be ignored, because, if taken by itself and disconnected from what has gone before, it is a notable piece of engineering in itself, dwarfed though it is by that remarkable example of masterly location on the immediate slopes of the mountain.

Along the North fork of the Catawba the work is comparatively light, although occasionally the fills run up to 25,000 cu. yds. and the cuts, in one case, to 80,000 cu. yds. It is the old story of projecting ridges and intervening ravines, until, a few miles above Marion, the valley leaves the river and widens to a mile or more, and the fertile bottom land is again in evidence. Then comes some exceptionally heavy work just



Located Line from Spruce Pine to Crossing of Catawba River.



Compensated Grades; Vance Tunnel to Honeycut Mountain Tunnel.

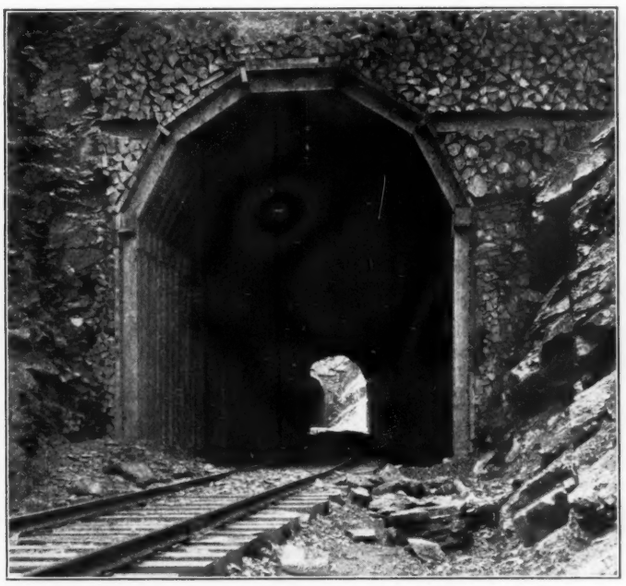
north of Marion where the hills crowd in close on the road, and there is one fill of 217,000 cu. yds. flanked by cuts of 109,000 and 105,000 cu. yds., respectively.

From Marion to Bostic, 28 miles, the location is through a heavy rolling country, involving for a modern line some exceedingly heavy steam shovel work. There are cuts running from 100,000 to 165,000 cu. yds., and in one case there is a fill of more than 285,000 cu. yds. The material in this region varies from a mica schist, where the slopes of cuts will stand very straight and true, to a soft clay that flows easily under pressure and is apt to come down in cuts and yield in fills until the equilibrium is reached on a slope of 2 to 1 or more.

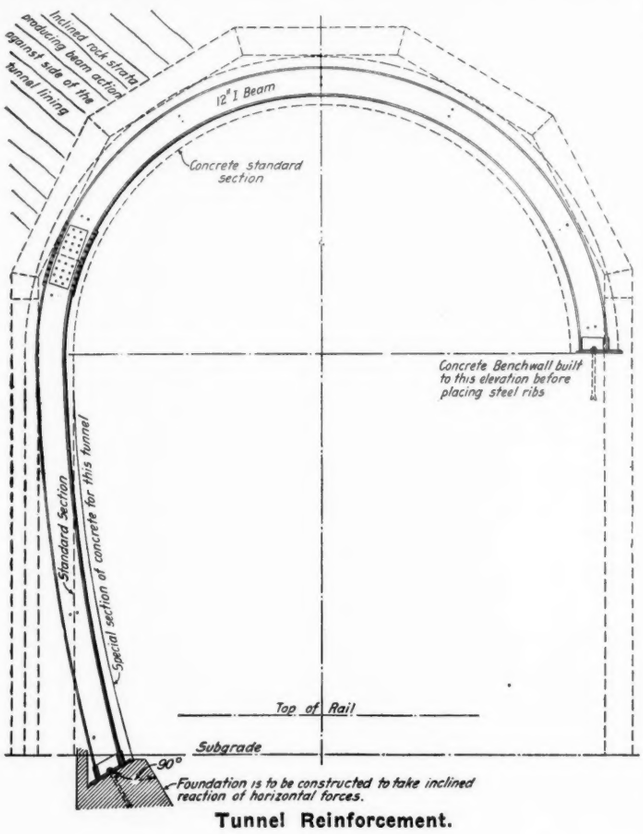
Soldiers' Home Cut, Johnson City, Tenn.

85 ft. at center. 500,000 cu. yds. removed.

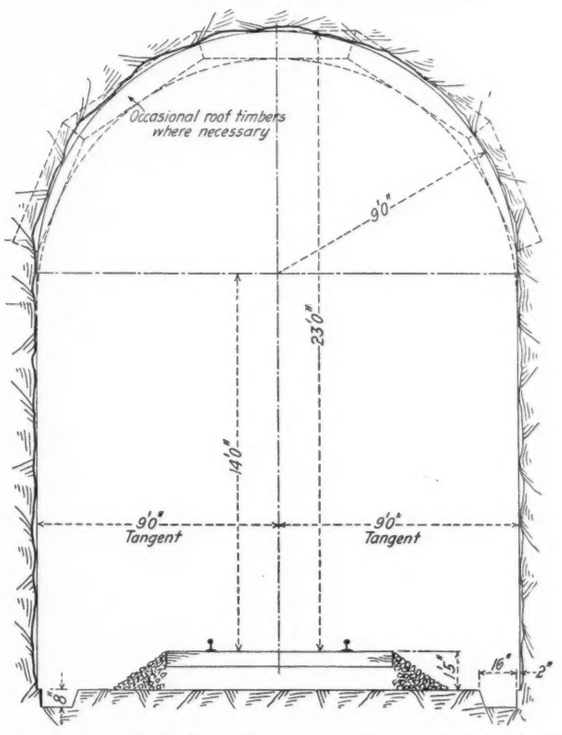
From Marion to Bostic there is an excellent opportunity to compare the old and new methods of location. For the whole distance the Clinchfield line is paralleled by an older road, built years ago when heavy trains were unknown, and present facilities for construction did not exist, so that low first cost had to be the object of the locating engineer. This line swings and twists among the hills, rising and falling with the local contours, using 1 per cent. grades uncompensated on curves with prodigal liberality, and so not only cutting down the locomotive capacity but adding a mile and a half to its length as compared with the new line. There are four or five summits in the distance, so that the estimated increase of rise and fall is three or four times that of its younger companion. The new road, on the other hand, drops down on an easy grade of .80 per cent. over curves of 4 deg. for about six miles, then for two miles climbs on a maximum of .5 per cent. to the summit, and then down into Bostic on the



Tunnel Portal, Showing Packing and Inclined Strata.


Inclined rock strata producing beam action against side of the tunnel lining
12" I Beam
Concrete standard section
Concrete Benchwall built to this elevation before placing steel ribs
Standard Section
Special section of concrete for this tunnel
Top of Rail
Subgrade
90°
Foundation is to be constructed to take inclined reaction of horizontal forces.

Tunnel Reinforcement.



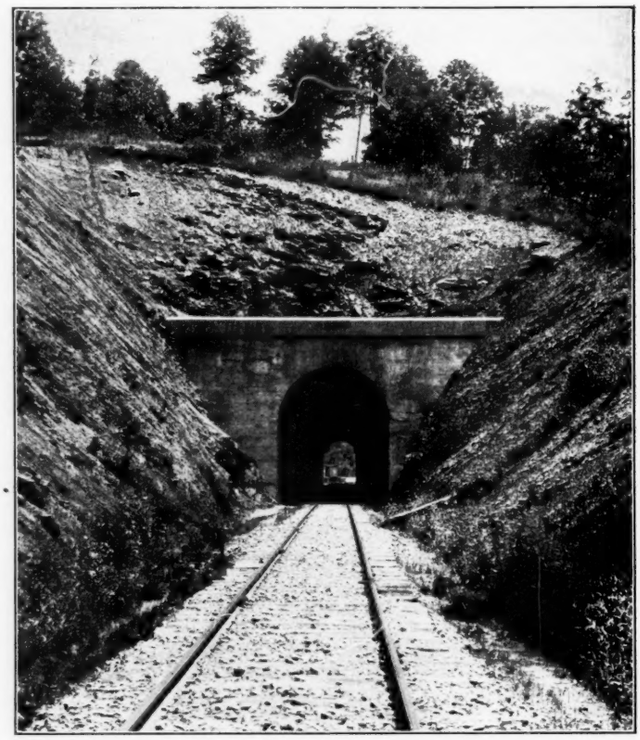
Standard Tunnel Section Where Permanent Lining Is Not Needed.

same grade and with the same curves as before. In one case we have a line adapted for high speeds and heavy trains; in the other, one that must always be limited in capacity and efficiency, although it was fully up to current demands and the prospects of future requirements at the time it was built. This difference of method is especially emphasized at one point, where, in order to avoid two grade crossings, the Clinchfield built a new track on its own alinement for the older road, and so reduced not only its grade but cut off 881 ft. in 2½ miles.

The location of the line has been treated fully in order to convey as clear an idea as possible of the character of the country and of what it means to put a modern low-grade line through it. It requires not only the highest grade of engineering talent to locate where others have searched and declared the obstacles unsurmountable, but it requires the assurance of a large and paying traffic from the start as well as implicit belief on the part of the investors that their assurance is well founded, and that its promises will not fail. What that is in the instance before us we shall presently see.

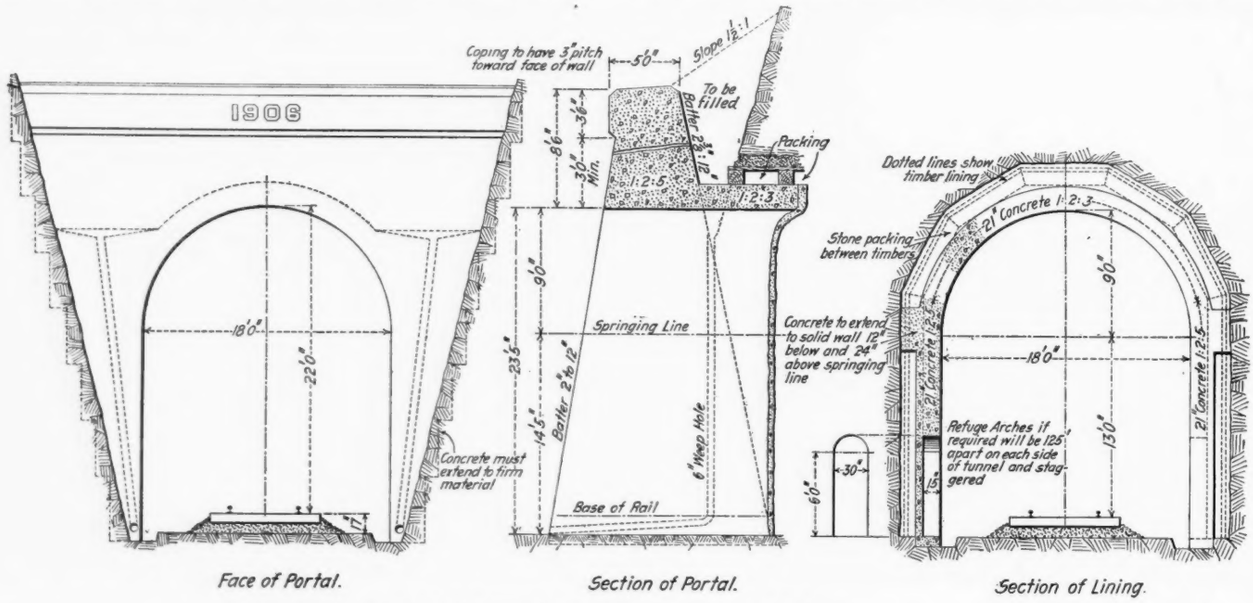
For use in passing the Blue Ridge and in furnishing construction camps with the necessary supplies, a light temporary line was built over the mountain. Where the yardage was heavy and the point remote from rail communications, other temporary lines were built across country from the nearest point having rail communication. In one instance this involved building a line four miles long. Where streams were in the way of the roadbed or threatened to wash it away, their course was changed and their channels straightened, as at Dante and on the north fork of the Catawba river. Where a bridge was needed to facilitate communication and connect the rails, erection was driven at top speed, as in the case of the bridge over the south fork of the Holston river, a deck-riveted truss of four spans of 120 ft., and two deck plate girders 60 ft. long, which was erected in 11 working days. Where steam shovel work was possible the excavating and hauling was kept at top notch. Thus, between Marion and Bostic, a total yardage of 3,100,000 was removed and the work was done at the rate of 30,000 cu. yds. a month by a single steam shovel. When this was completed it was followed by track laying that, with a track-laying machine, touched 9,750 ft. a day. The whole line of track and bridges between Marion and Bostic was completed in less than three months. Now that the rails are down, the work of taking up sags in the fills, keeping the track up to grade and the placing of ballast is being followed with the same vigor. It seems probable that, before the summer is over, the settlement and movement will have so far ceased that normal conditions of operation can be maintained over the whole line.

To sum up what has been done, there is, first of all, a road 209 miles long, all over a heavy location, and part of it here-

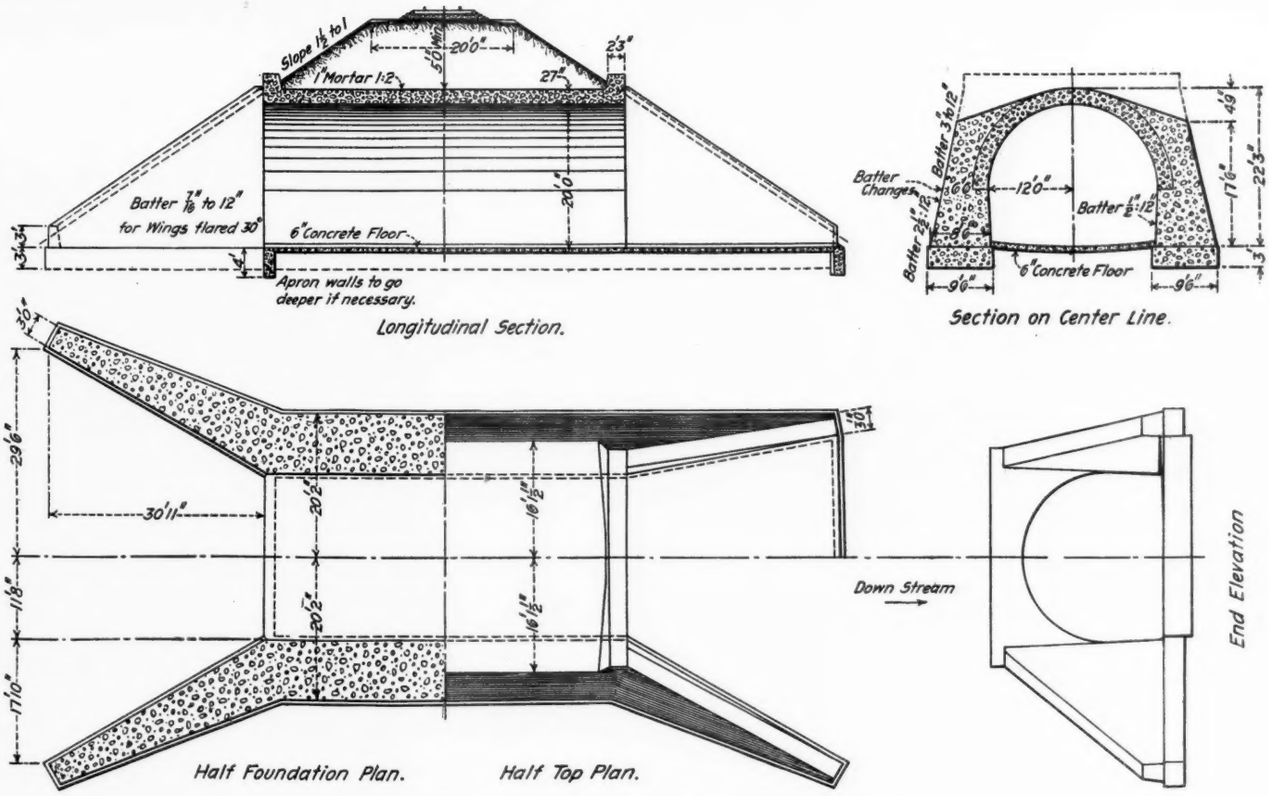


Portal of Vance Tunnel, near Altapass, N. C.

tofore regarded as impassible. The construction involved moving 16,000,000 cu. yds. of material from cuts and placing the same amount in fills, a task that was somewhat increased because of the impossibility of always effecting a perfect balance, with resultant waste and borrowing. Of this material about 40 per cent. was solid rock, 20 per cent. loose rock and 40 per cent. earth. There were also required 225,000 cu. yds. of masonry and 6,800 tons of cast iron pipe for



Standard Concrete Tunnel Portal and Lining.

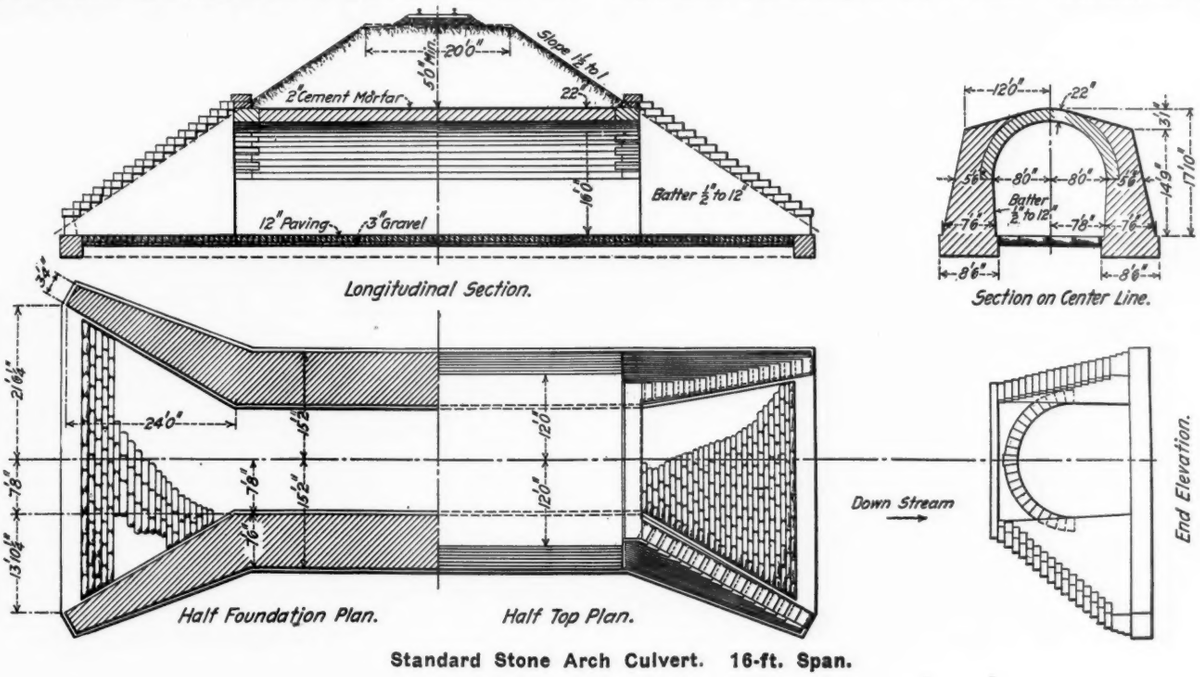


Standard Concrete Arch Culvert. 24 ft. Span.

culverts. On the line there are 36 tunnels aggregating about six miles in length, while 7,000 tons of steel were used in the bridges. For the uncompleted portions of the line between Bostic and Spartanburg and Dante and Elkhorn, Ky., the estimates are that between the two former places there will be 2,000,000 cu. yds. of cut and the same of fill, about half of which is completed, and, between Dante and Elkhorn, there will be 2,500,000 cu. yds. of each.

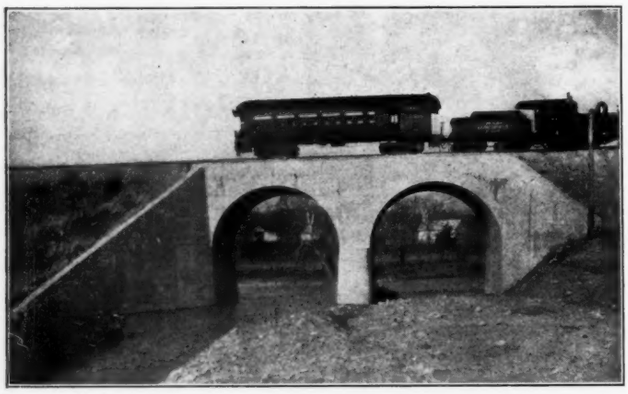
TUNNELS.

The location across the mountain spurs often involved tunnels at frequent intervals, as on the south slope of the Blue Ridge, where in one case there are three closely spaced on a short tangent. Allusion has already been made to the unreliable character of much of the material removed from the cuts. A similar difficulty had to be met in much of the tunnel work. In a number of cases the roofs would not stand without timbering, and in some instances the timbering that was used was subjected to very severe stresses because of the tendency of the rock to slide. After the coal deposits and their accompanying shales have been left behind, the rocks have been subjected to an upheaval action, and stand at all angles from a horizontal to the vertical. Frequently the dip



Standard Stone Arch Culvert. 16-ft. Span.

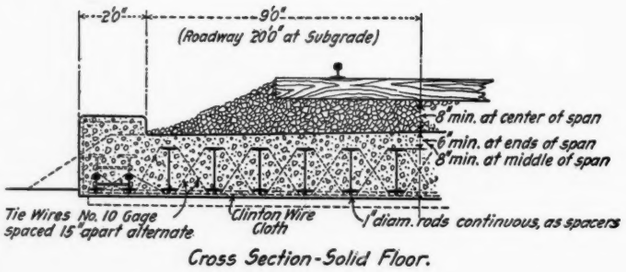
crosses the tunnel line at a sharp angle. Towne's tunnel in the Clinch valley is one of a number of examples where extraordinary measures had to be taken to prevent a cave-in of the roof and sides. The rock is a carboniferous shale, so tilted that the dip of the strata lies at an angle of about 30 deg. with the horizontal, and the material presses in so hard that the timbering is under a heavy stress. The vertical 12-in. x 12-in. side timbers are bent 2 in. out of line



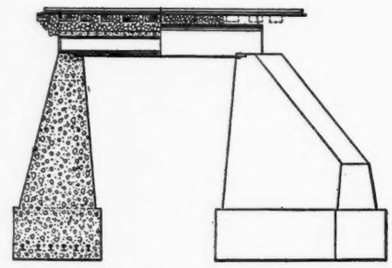
Reedy Creek Concrete Arch Bridge.

in places, and in some cases double timbering has been required to hold the load, and even this is badly bent. In order to carry the roof and sides permanently and stiffen the concrete lining against side thrusts, it has been reinforced by a 12-in. I-beam bent to a semi-circle with one end resting on the concrete base and the other riveted to a straight leg that comes down the side of the tunnel on a batter and has its foot carried by a concrete pedestal at the bottom. The whole is buried in and covered to a depth of 4 in. by the concrete lining. By comparing the resulting contour with that of the standard it will be seen that some of the bottom clearance is sacrificed, but the tunnel is of ample width to permit this. The steel beams are bent and afterwards annealed, and are set on from 2-ft. to 5-ft. centers, dependent upon the character of the rock and the intensity of the pressure that they will be called upon to carry. The stresses on this reinforcement were calculated on the basis of a uniformly loaded beam, on the hypothesis that the timbering was upon the point of fracture.

For the regular tunnel construction two standard sections have been adopted. One is that used in rock that is solid enough to stand without timbering, and which has an arched


2'0"
9'0"
(Roadway 20'0" at Subgrade)
8" min. at center of span
6" min. at ends of span
8" min. at middle of span
Tie Wires No. 10 Gage spaced 15" apart alternate
Clinton Wire Cloth
1" diam. rods continuous, as spacers

Cross Section-Solid Floor.



Cross Section. Side Elevation.

Standard I-Beam.

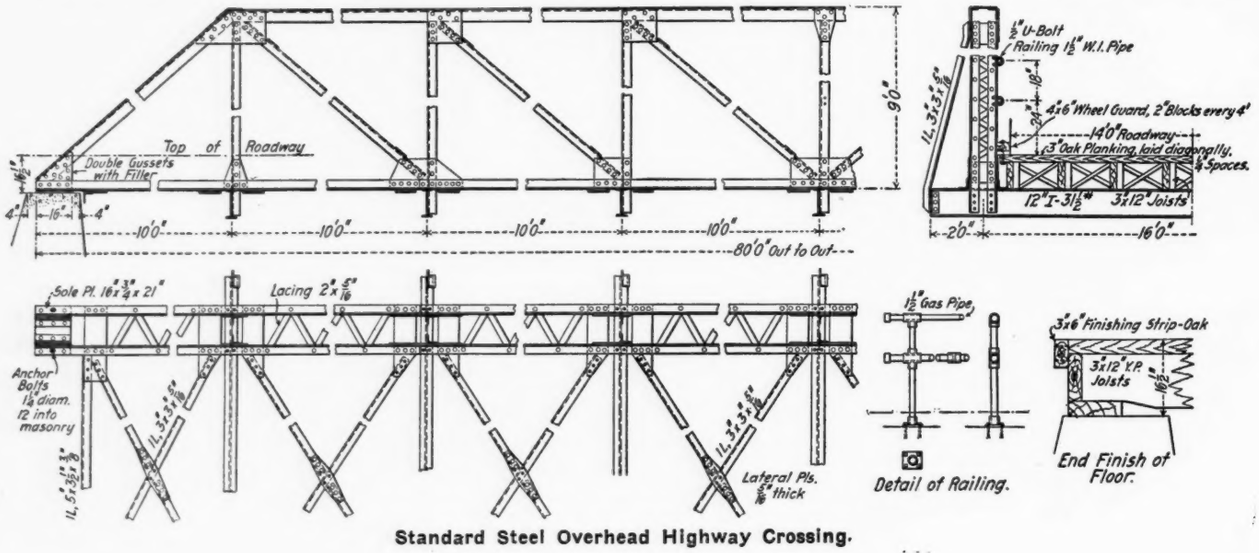
Concrete Bridge, for clear spans 10 ft. to 24 ft. Live load—Cooper's E-60.

roof of 9 ft. radius with a total width of 18 ft., with adjustments of track on curves to maintain ample clearances. The schedule that has been issued for this increase is as follows:

Degree of curve.	Distance from center line of track. Inside of curve.	Outside of curve.
1 deg.	9.21 ft.	8.79 ft.
2 "	9.41 "	8.59 "
3 "	9.56 "	8.44 "
4 "	9.68 "	8.32 "
5 "	9.81 "	8.19 "
6 "	9.94 "	8.06 "
7 "	9.97 "	8.03 "
8 "	9.98 "	8.02 "

Where tunnels are on curves of more than 8 deg. special instructions are issued as to clearance.

Tunnels lined with concrete have the same inside dimensions, but the excavation is made enough larger to permit the use of 21 in. of concrete inside the timbering which is always left in position. The space between the timbers is packed with spalls when they can be conveniently obtained; and when not, cordwood is packed in above the concrete and against the rock. The principle upon which this is done is that the wood will not decay so long as the air does



Standard Steel Overhead Highway Crossing.

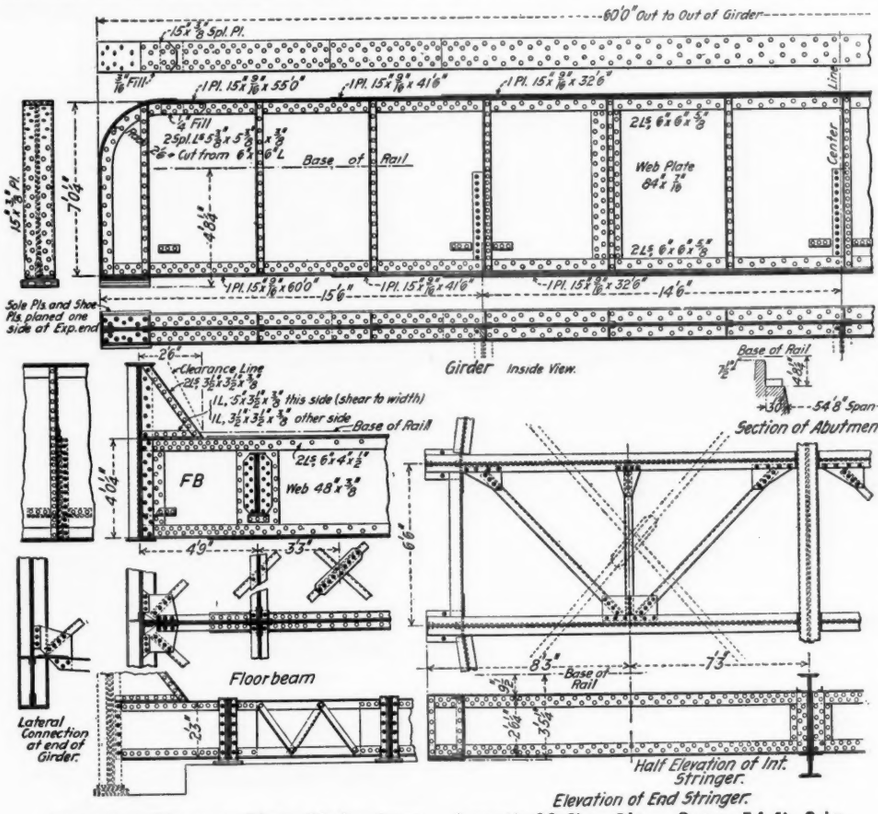
not have access to it, and this condition is considered existent in this case. The concrete for the arch is a 1-2-3 mixture, and that for the side walls is a 1-2-5. These are rather richer mixtures than those frequently used. The reason therefor lies in the nature of the sand that is obtainable. Mica is an almost omnipresent mineral and it gives to most of the sands such a slippery quality that it is not safe to use any of them without testing, and this is done in all cases. Then, in order to raise their quality to that of standard sand a percentage of crusher screenings, as determined in the laboratory, is added.

At the sides of the tunnel lining the concrete is carried out to the solid wall for a distance of 2 ft. above and 1 ft. below the springing line of the arch so as to make sure that the thrust is carried out against the rock by the concrete and not through the packing. The sides are provided with refuge niches, staggered and set 125 ft. apart on each side. The faces of the walls are coated with 1 in. of 1-2 mortar applied when the forms are filled.

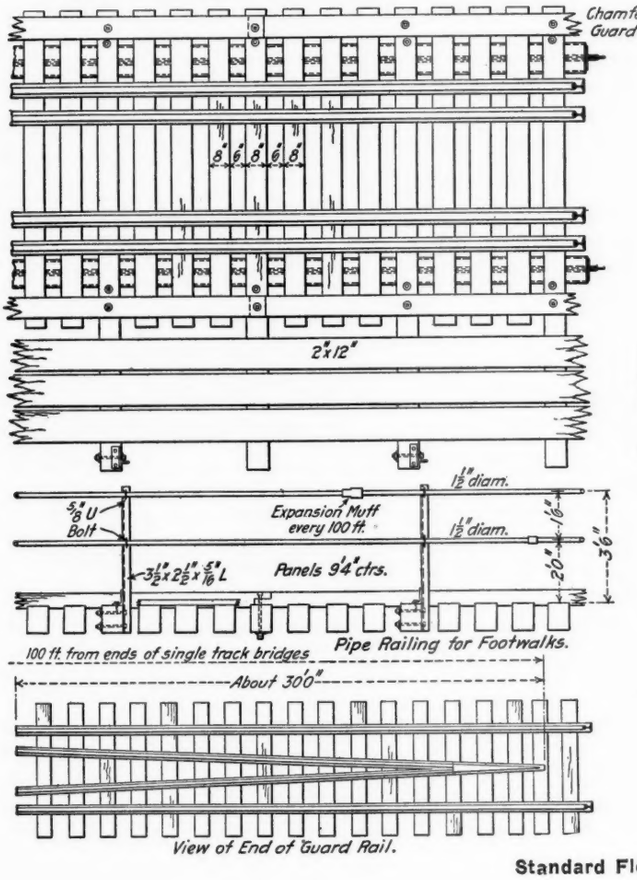
The portals are capped with a parapet, as shown, made of 1-2-5 concrete and provided with weep holes to take care of the drainage from the bank behind. They have a batter at the front of 2 in. to the foot and are also faced with a 1-2 cement mortar applied as before.

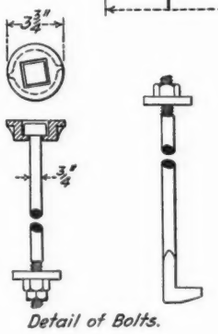
BRIDGES AND CULVERTS.

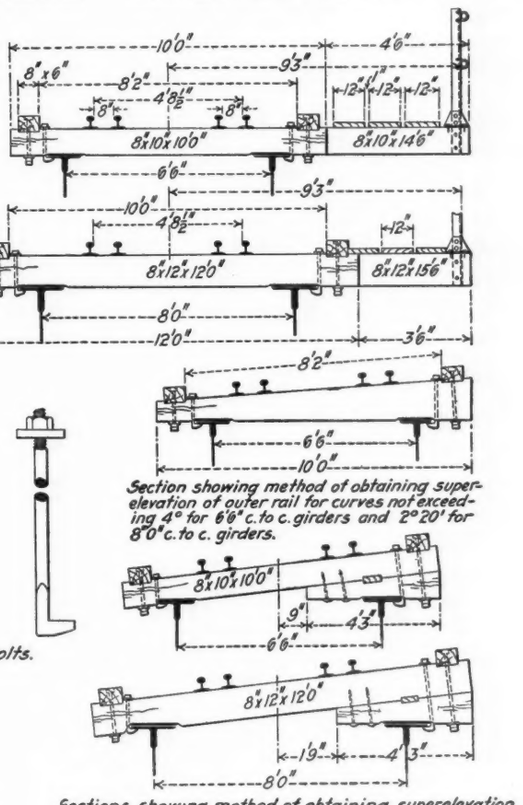
Paralleling the tunnels in importance on the road are the water course crossings, which vary from the cast



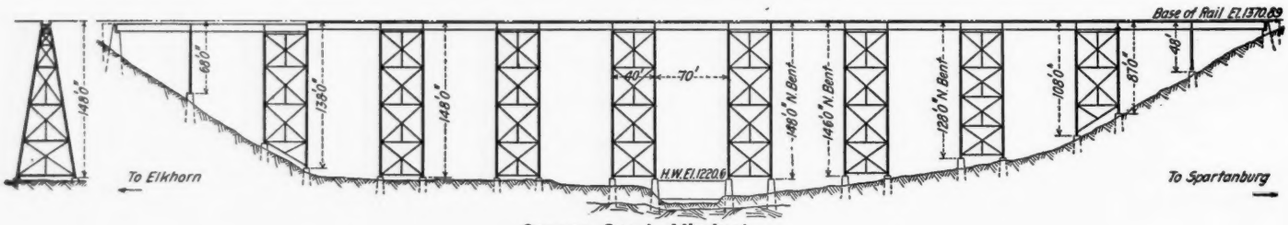
Standard Through Plate Girder Span. Length 60 ft. Clear Span, 54 ft. 8 in.


Chamfer edges of Guard Timber
2"x12"
Expansion Muff every 100 ft.
Panels 9'4" ctrs.
Pipe Railing for Footwalks.
100 ft. from ends of single track bridges
About 30'0"
View of End of Guard Rail.




Section showing method of obtaining superelevation of outer rail for curves not exceeding 4° for 6'6" c. to c. girders and 2°20' for 8'0" c. to c. girders.
Sections showing method of obtaining superelevation of outer rail for curves exceeding 4° for 6'6" c. to c. of girders and 2°20' for 8'0" c. to c. of girders

Standard Floor for Bridges.



Copper Creek Viaduct.

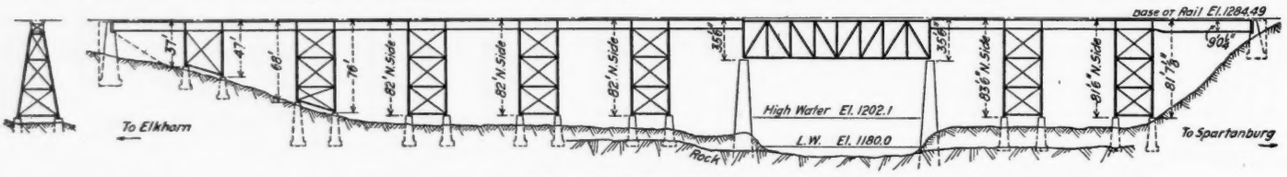
iron pipe buried beneath a fill to the bridges and viaducts several hundred feet long. Cast iron pipe are used wherever possible, in diameters up to 48 in. When two such pipe are insufficient to provide the necessary area of waterway, box culverts are used of increasing size until a bridge becomes necessary.

In the concrete used in the culverts, abutments and wing walls, little or no reinforcing is used. The illustration of the 24-ft. concrete viaduct shows a typical structure as used for various spans on the road. The foundations will, of course, extend deeper wherever it may be necessary in order to obtain a proper footing. The downstream wing walls are either straight or flared, according to local conditions, such as the shape of the banks, the rate of discharge and similar conditions. The quality of the concrete varies with the location in the structure. For example, it is a 1-3-6 mixture in the foundations and backings, a 1-2-5 in the side walls, wings, parapets and paving, and a 1-2-3 in the arch. The specifications allow angular stone that can be handled by one man to be used in the abutments and backing, provided they are placed not less than 4 in. apart in the clear and are wholly embedded in the concrete. Finally, the crown of the arch is coated on the outside with a 1-2 mortar.

Provision is also made in the standards of the company for stone arch culverts, as illustrated. If the arch is built of brick, 5 rings are used and these receive an outside coating of 1 in. of 1-2 cement mortar. Other than this the requirements as to shape and dimensions of wing walls and foundations are the same as for the concrete culverts.

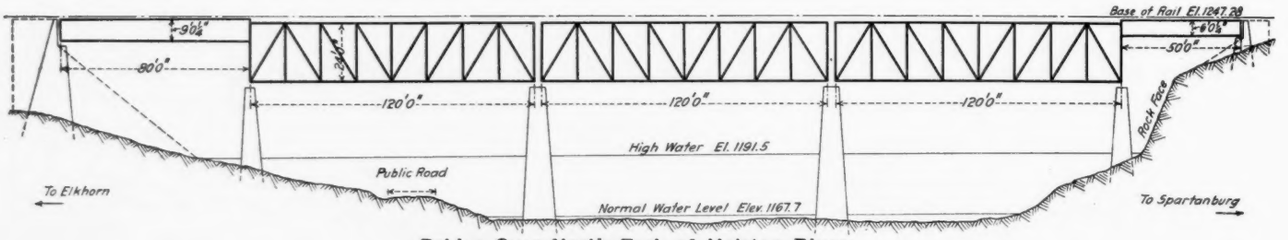
For shorter spans the reinforced box culvert is used. In this, for both the single and double culverts of 4 ft. spans, the top slab is reinforced by tension rods at the bottom, with diagonals reaching up to the ends. For the longer or 6-ft. spans old rails are used, with a layer of wire cloth of 3 in. x 8 in. mesh set 1 in. below the rails and the whole embedded in a 1-ft. slab of 1-2-3 concrete.

When the spans rise above these dimensions an I-beam concrete bridge is used. This form of construction is used for spans of from 10 ft. to 24 ft., though it by no means follows that it is used instead of plate girders for the longer spans.



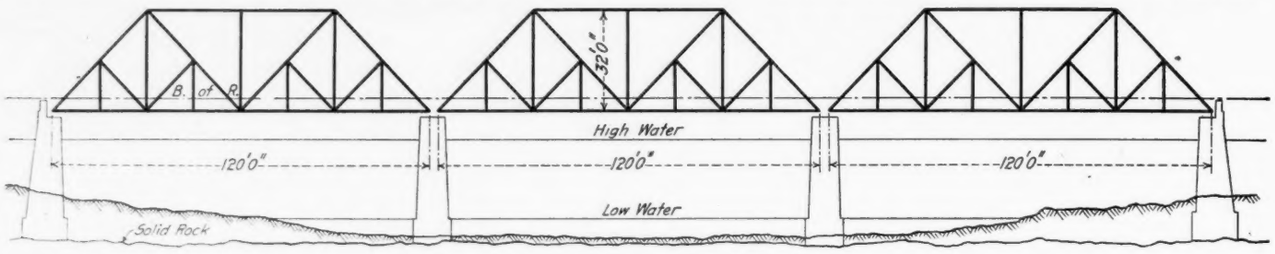
Catawba River Bridge.

The cross section shows the method of construction very clearly. The I beams rest at either end on seats formed of rails embedded in the abutments, and are tied together by No. 10 wire spaced 15 in. apart and fastened to a wire cloth netting placed 1 in. below the bottom of the beams, with 1-in. round rods set in between as spaces. The concrete is flat at the bottom and is 2 in. thick below the beams and is crowning at the top, both longitudinally and transversely, with a minimum thickness of 8 in. at the center, of 4 in. at the sides and 6 in. at the ends. Along the sides there is a curb 2 ft. wide and rising 6 in. above the floor to prevent the ballast from flowing away. In the curb and filling, the 1-2-3 mixture is used, in which 1 in. is the maximum dimension for the stone, and the top surfaces are plastered with 1 in. of 1-2 cement mortar, well troweled so as to shed water. The sections and quantities used for this type of crossing of various spans is as shown in the table on the following page.

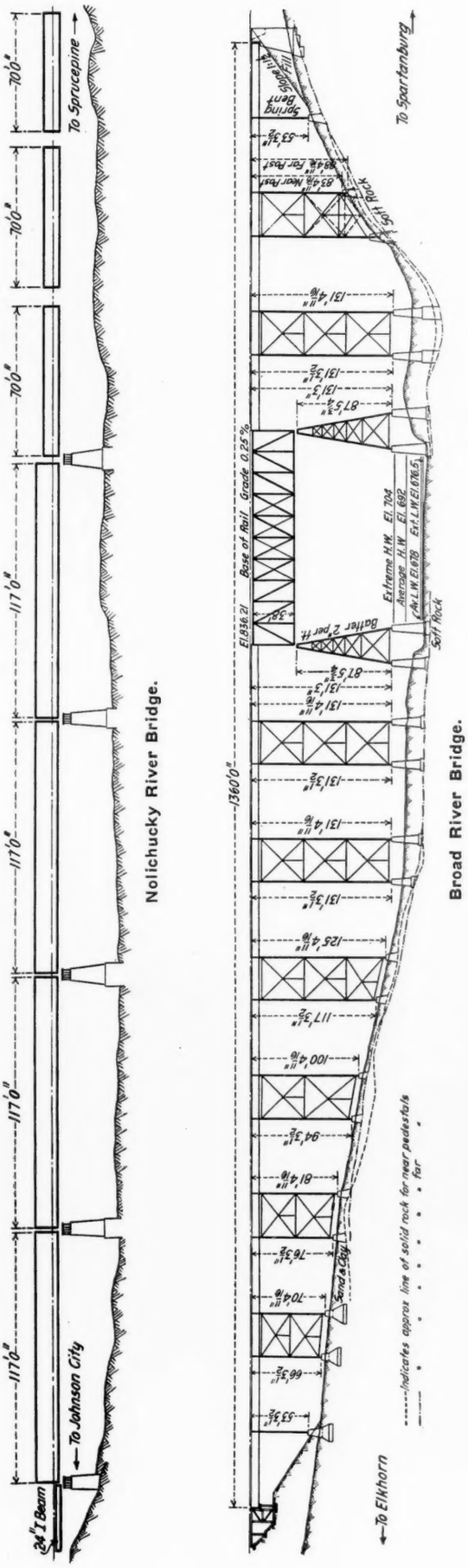


Bridge Over North Fork of Holston River.

Closely allied to the I-beam construction, as far as span is concerned, is the concrete arch bridge, a few of which are used. That at Reedy creek is a good example. The concrete

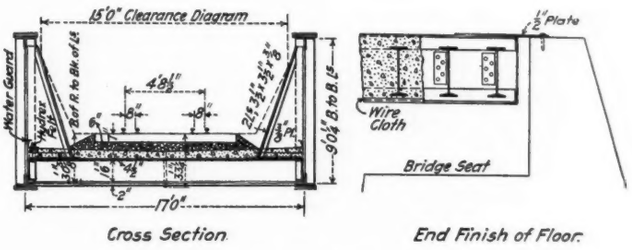


Starnes Bend Bridge Over the Clinch River.



is not reinforced, but stands by itself, except for a line of wire cloth near the inner surface that acts as a temperature reinforcement. In the case referred to each of the two arches is of 30-ft. span.

Next in order of magnitude of span comes the girder bridge,



Details; Kendrick's Creek Bridge.

an example of the design of which is given in the illustration of the 60-ft. span. One of the first points that strikes the eye in looking at one of these bridges in position is the great

Spans, Number and Sections Used in Crossings.

Span.	No. I-beams.	Section.
10 ft.	8	15 in. 42 lbs.
12 "	12	15 " 42 "
14 "	12	15 " 60 "
16 "	{10	18 " 60 "
	{4	12 " 31½ "
18 "	{10	20 " 65 "
	{4	12 " 31½ "
20 "	{10	20 " 80 "
	{4	12 " 31½ "
22 "	{10	24 " 80 "
	{4	12 " 31½ "
24 "	{10	24 " 95 "
	{4	12 " 31½ "

depth as compared to the span. The specifications issued require that the depth shall preferably be not less than one-twelfth the span and as great as economical conditions will

Clinch River Bridge at Starnes Bend.
3 spans of 120 ft. each.

permit. This requirement is always more than met and, in many cases, the depth is fully one-eighth the span, as in the case illustrated.

The standard loading for all bridges on the line is Cooper's Class E 60, consisting of two consolidation engines, weighing

213 tons each, including tender, and followed by a train load of 6,000 lbs. per lineal foot. To this is added the effects of impact and vibration, determined from the formula:

$$I = S\left(\frac{300}{L + 300}\right)$$

in which

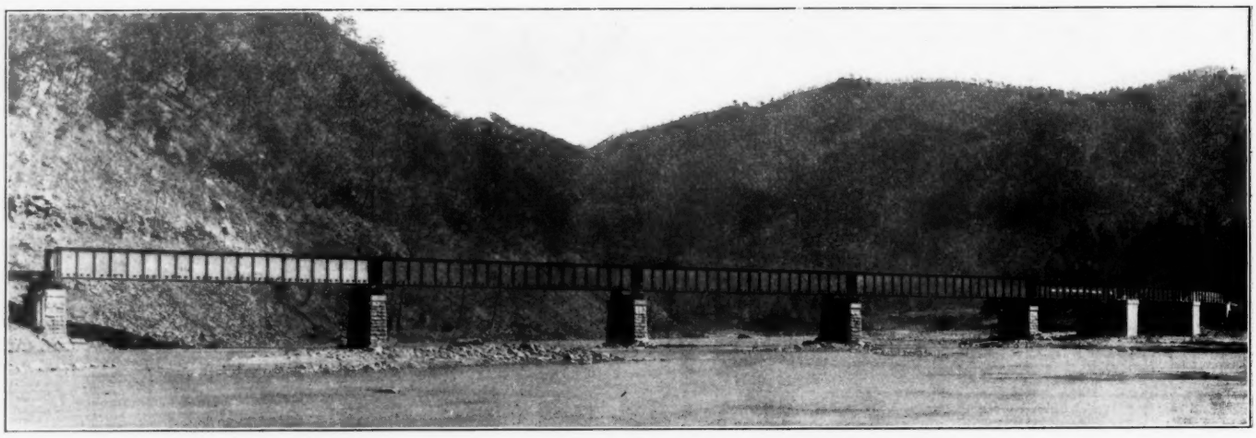
I = Impact.
S = Calculated maximum live load stress.
L = Length of loading which produces the maximum stress in the member.

All parts of the structure are so proportioned that the sum of the maximum stresses shall not exceed the following amounts in pounds per sq. in., except that the combined stresses from wind and other loads may increase the unit stresses by 25 per cent:

Tension, net section, 16,000.

Compression, gross section, $16{,}000 - 70\frac{l}{r}$.

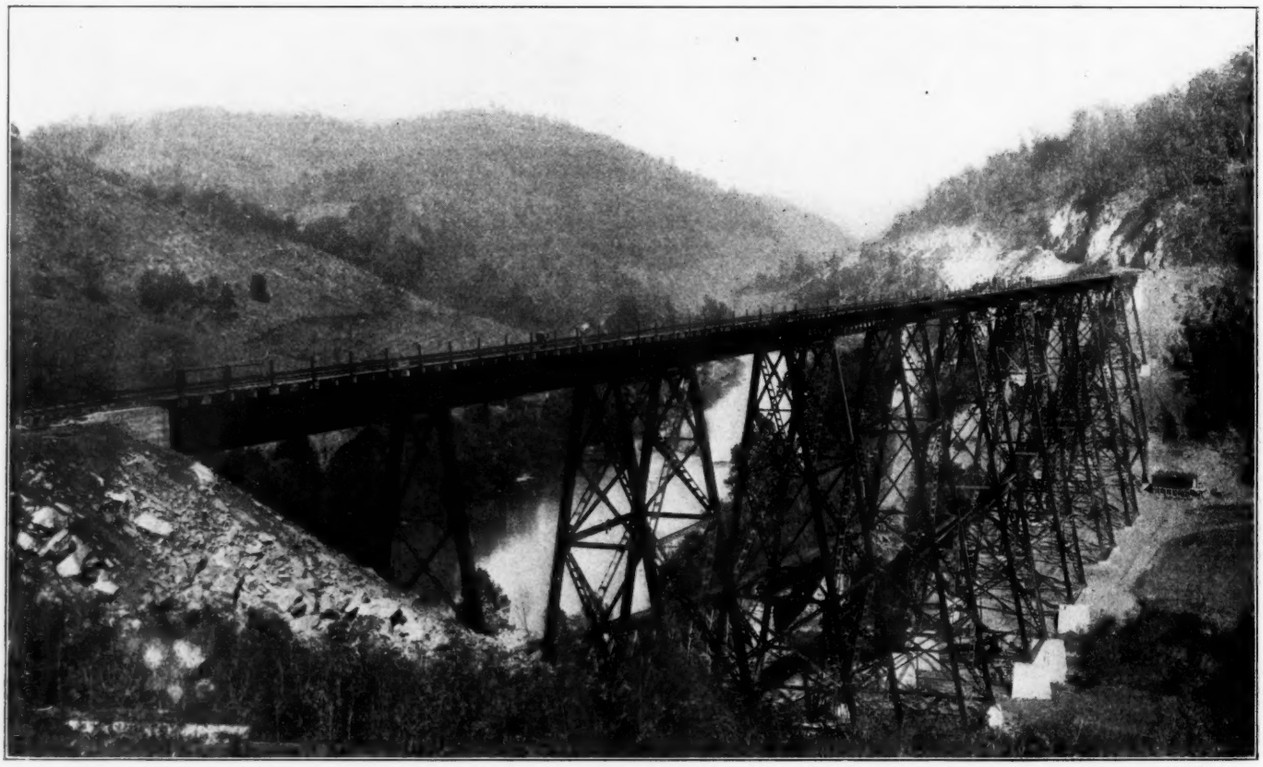
Shear on shop-driven rivets and pins, 12,000.
Shear on turned bolts, 9,000.
Shear on plate girder webs, cross section, 10,000.
Bearing on pins and rivets, shop driven, 24,000.
Bearing on turned bolts, 18,000.
Fiber stress on pins, 24,000.



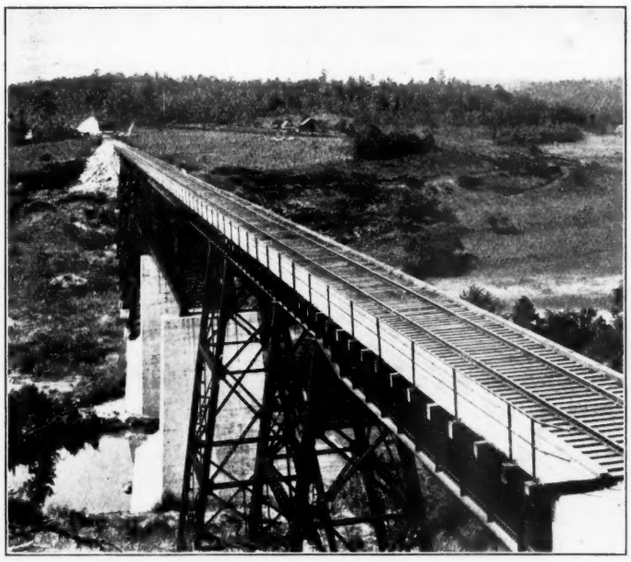
Nolichucky River Bridge—Unaka Springs, Tenn.
4 spans of 117 ft. each; 3 spans of 70 ft. each.

Expansion bearings on flat surfaces, 2,000.
Expansion bearings on rollers, per linear inch, 600 × D.
Bearing plates on granite masonry, 600.
Bearing plates on sandstone and limestone, 500.
Bearing plates on Portland cement concrete, 500.

l = Length of member.
r = Least radius of gyration.
D = Diameter of roller.



Copper Creek Viaduct, near Clinchport, Va. (1,360 ft. Long. 168 ft. Base of Rail to Stream.) Erected Complete in Five Weeks.



Catawba River Bridge. 840 ft. Long.

Channel span, 150 ft. long. Tower girders, 30 ft. long. Intermediate spans, 60 ft. and 80 ft. long. River piers, 73 ft. above water level.

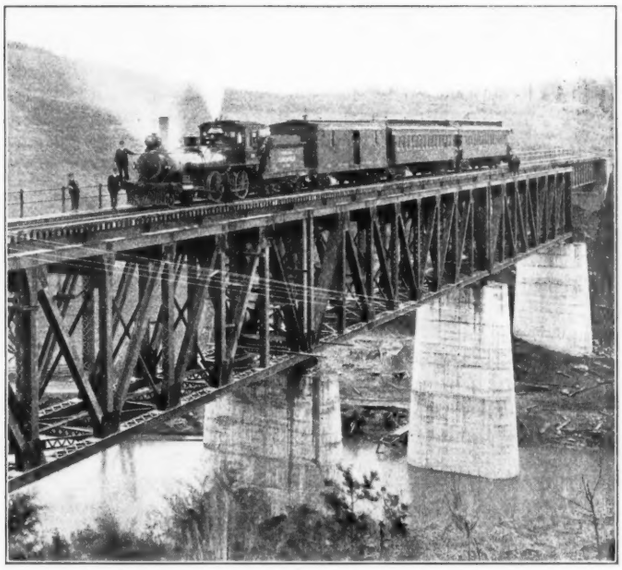
All dimensions in inches. These specifications are essentially those adopted by the American Ry. Engineering and M. W. Association.

Attention is called to these unit stresses as being quite in accord with the older and more conservative ones, and as far below those that have recently been applied to structures of great magnitude that have not been wholly satisfactory or safe, and which have consequently been subjected to rather severe criticism.

In the general design of these girder bridges, there is nothing particularly novel other than those indicated, with local exceptions, to some of which attention will be called later. The girder bridges are built without any camber. The upper corners of abutment ends of through plate girders are rounded to a radius of about one-third the depth of the girder, which radius is never to be less than 18 in.

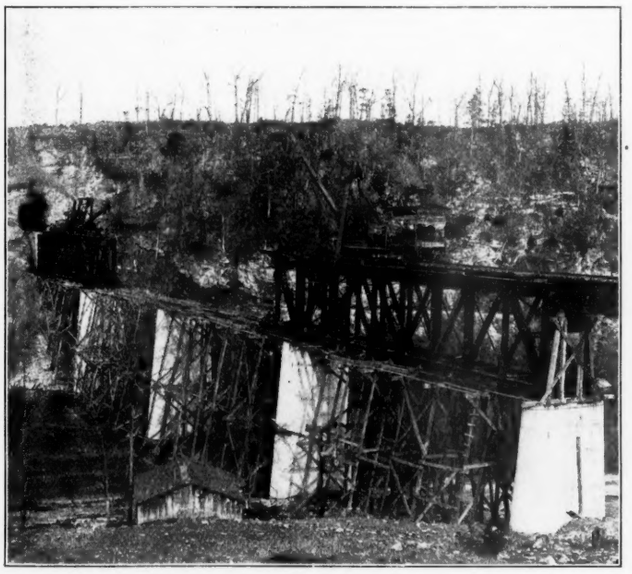
Before considering the viaducts and pin and riveted bridges, attention is called to the floor used on the structures. The girders are spaced 6 ft. 6 in. and 8 ft. from center to center, according to length of span, and the ties are spaced 6 in. apart. The ties are held to the girders by hook bolts and each fourth one is lengthened to 15 ft. 6 in. to support a footwalk 3 ft. 2 in. wide along one side of each bridge, 200 ft. or more long. The outer edge of this is protected by a railing whose uprights are 3-in. angles with the pipe rails held in place by U bolts. This is an exceedingly stiff construction and is markedly stronger than the one usually made with pipe posts held to the ties by flanges and lag screws. An inner guard rail set 8 in. from the rail is used on all bridges of more than 20 ft. span, and is carried out to a distance of 100 ft. from each end of single-track bridges where the two rails come together in a frog point.

For cases other than for deck plate girder spans that can be tilted by means of shoes of unequal depth, two methods of obtaining the superelevation of the rail on bridges are in use. One is for curves not exceeding 4 deg. on girders 6 ft. 6 in. between centers. In this a tie thicker at one end than at the other is used with an even taper from end to end. This construction is also used on curves up to 2 deg. 20 min., where the girders are 8 ft. between centers. For curves exceeding 4 deg., with girder spacing of 6 ft. 6 in. as well as 8 ft., a plain straight tie is used, notched on the low side to fit over and rest squarely on the girder, and carried at the other end by a wedge of the proper thickness, to which it is both spiked and bolted and prevented from slipping by a 2-in. x 6-in. x 8 in. oak key gained into both pieces, and then bolted to the girder by the usual hook bolt. For girders 6 ft. 6 in. between centers, the ties are 8 in. x 10 in. x 10 ft. long; for the 8-ft. distance these dimensions are increased to 8 in. x 12 in. x 12 in., the same sectional dimensions for the ties holding for the work on curves.



Bridge Over North Fork of Holston River.

3 spans of 120 ft. each; 1 span of 30 ft.; 1 span of 50 ft.



Bridge Over South Fork of Holston River. Steel Work for This Structure Was Erected Complete in 11 Working Days.

4 spans of 120 ft. each; 2 spans of 60 ft. each.

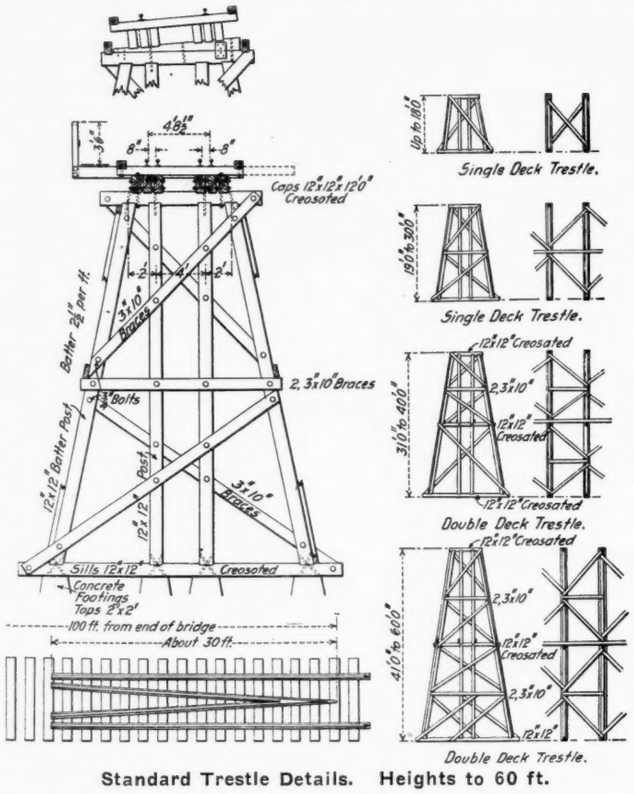
Another form of floor used on certain plate girder bridges where a shallow construction is necessary is the colid concrete. In this form the cross floor beams are I-shaped built in with the girders. A concrete slab floor is built in between and embedding the I beams. It extends down for 2 in. below the bottom of the beams and has a wire cloth of 3-in. x 8-in. mesh in it, set 1 in. below the bottom of the beams. At the top the concrete has a minimum thickness of 4½ in. and with a concave upper surface rising to about 12 in. at the sides. Here there is also a water guard of waterproofing material, over which there is a steel guard formed of a 3-in. x 2½-in. x ¼-in. angle, placed between the stiffeners and bolted to the

girder with ⅞-in. bolts. The ballast and ties are then placed on the bridge in the usual manner with a depth of about 6 in. of ballast below the ties. For the concrete, the 1-2-3 mixtures is used with stone that will pass a 1-in. ring. Drainage is obtained by 4-in. wrought iron drip tubes passing down through the concrete on the center line of track.

There are several long plate girder bridges on the line, among the most notable of which is that over the Nolichucky river near the lower entrance to the gorge, to which allusion has already been made. This bridge is a through plate girder construction, having four 117-ft. and three 70-ft. spans. In the design all parts have been planned so that they can be used again without alteration in case a revision of the line should be made and a new crossing effected at this point. The girders can be used for a deck span and the floor beams can be used for shallow concrete floors such as that illustrated. In the outline of the bridge shown, it appears that there is a 30-ft. span not provided for in the above list. It has been decided, however, to do away with this, build wing walls to the pier, fill in the opening and thus substitute a fill for this span.

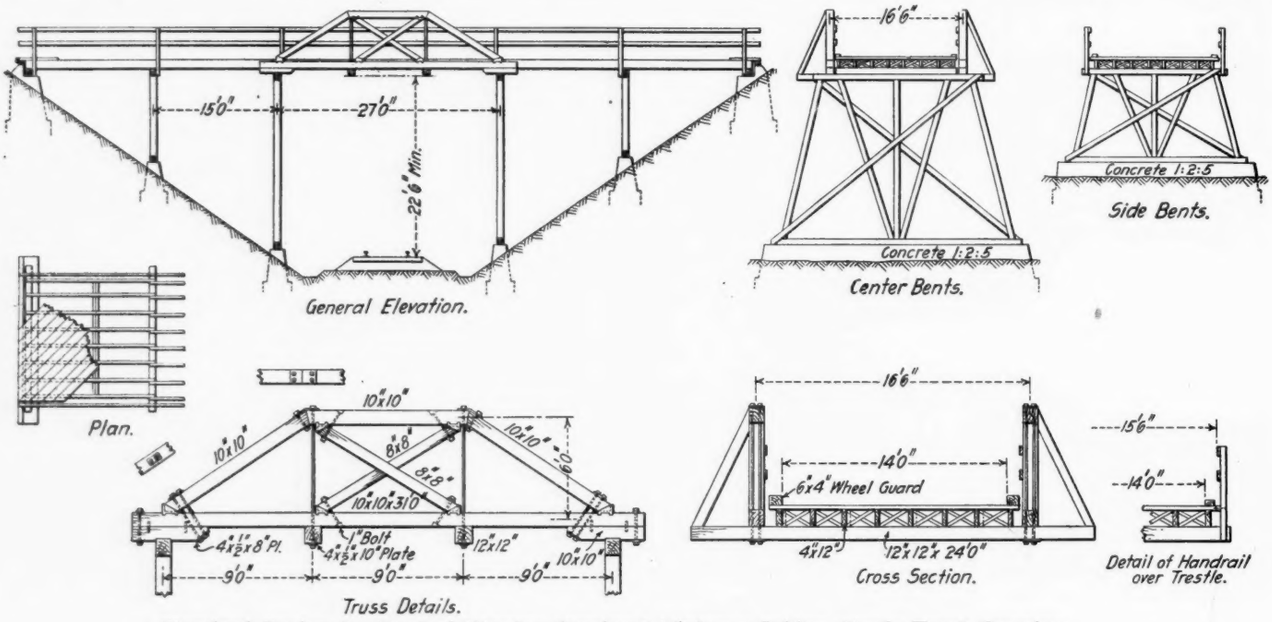
The statement has already been made that it has been the policy of the road to use fills instead of viaducts except where local conditions prevent. One of these places is at Copper creek a short distance west of the Clinch mountain tunnel. At this point a broad ravine is crossed by a deck plate girder viaduct 1,090 ft. 8 in. long and 168 ft. from the bed of the stream to the base of the rail. The tower spans are 40 ft. and the intermediates 70 ft. With this arrangement there are eight towers and nine 70-ft. spans, as well as 70-ft. 4-in. spans at each end. The outer ends of the latter, with the adjoining 70-ft. spans, are carried on single rocker bents. The towers are footed on concrete pedestals, and those for the center spans have a height of 148 ft. to the base of rail and are four stories high. In the construction of this viaduct 1,510 tons of steel were used.

Other viaducts are combinations of the plate girder and riveted truss spans. Such a bridge is that over the Catawba river. In this, the tower spans are not as high as at Copper creek, and the spans are cut to 30 ft. with 60 ft. for the intermediate. The principal point of interest in this bridge is to be found in the channel span, which is 150 ft. This is a riveted deck truss span with a depth of 30 ft., or one-fifth the span. Instead of carrying the ends of this truss on steel towers, as has been done elsewhere, and which involves a breaking of the batter of the tower legs and a concentration of expansion stresses, two concrete piers that are 90 ft. high to the bottom of the foundation are used. With this, the expansion of the adjoining plate girders is taken on the seats on the tresses, and there is a corresponding reduction of thrust. In addition to this, the piers are far better adapted to resist the action of flood waters than steel towers would be, and will require no future attention or maintenance charges. This design, in addition to being especially well adapted to the location, presents a very artistic appearance when viewed from any direction.



Standard Trestle Details. Heights to 60 ft.

As the road thus far constructed lies among the mountains and therefore on the headwaters of the streams, it follows that the spans are usually short, and so have been confined

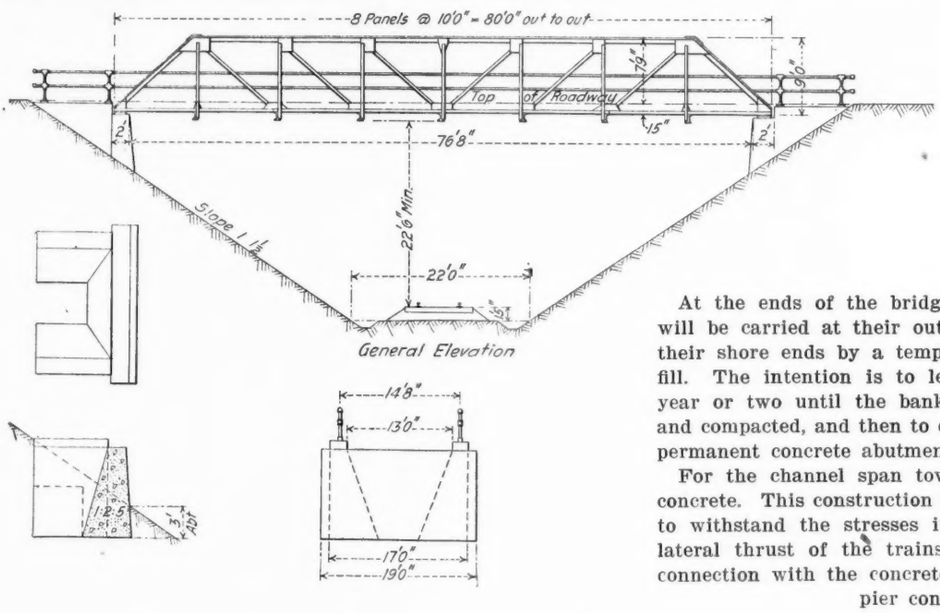


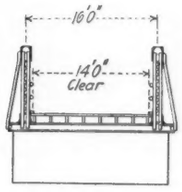
Standard Design for Typical Wooden Overhead Highway Bridge, Single Track Crossing.

exclusively to plate girders and riveted truss spans. In these it has been the aim to make the depth of the trusses as great as economical conditions will permit. In the case of the Starnes bend bridge over the Clinch river, which is illustrated as typical of the through truss construction, the depth is 32 ft. from center to center of chords on 120-ft. spans, with eight panels of 15 ft. each. This is an open-floor structure for single track, and is built according to the standard bridge specifications of the road.

Another type of riveted truss is illustrated by those over the North and South forks of the Holston river, in which the former is shown completed and the latter with the falsework in position during construction. In the case of that over the North fork, the bridge consists of three single-track spans of deck-riveted trusses with an open floor. Each span has a length of 120 ft. with a depth of 24 ft. from center to center of chords and a width of 13 ft. from center to center of trusses. The piers are of 1-2-5 concrete on 123-ft. centers. As indicated on the outline, there is likely to be a rise of 26½ ft. between low and high water, so that a bridge across the whole opening of the valley was a local necessity.

When the road has escaped from the mountains and come out from among the foothills to the lower levels of the open country, the streams become wider and bridges of longer span will be required. For this work the pin-connected structure will be used, as in the case of the Broad river crossing, which is on the Bostic-Spartanburg extension and which is now being vigorously pushed to completion. This bridge is a combination viaduct and bridge in which the towers and spans are similar to those used on Copper creek. That is, the tower spans are 40 ft. and the intermediates are 70 ft. These dimensions are used at all points when the height is over 100 ft., whereas when the height is less than 100 ft. the dimensions are made 30 ft. and 60 ft., respectively. As on other roads, the pin-connected truss is used where the span exceeds 150 ft. In the case of Broad river, where the channel span is 200 ft., that type is used. The depth of the truss is 38 ft. from center to center of chords and the trusses are 16 ft. between centers.





Cross Section.

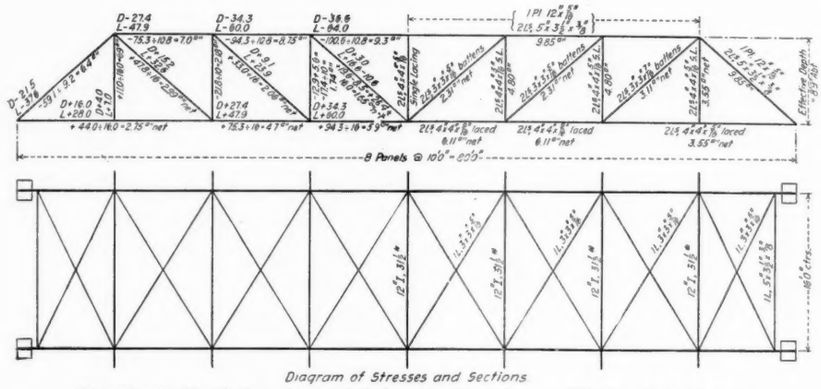


Diagram of Stresses and Sections.

Standard Steel Overhead Highway Crossing. 80 ft., Out-to-Out.

At the ends of the bridge there are 70-ft. girders which will be carried at their outer ends by rocker bents and at their shore ends by a temporary wooden crib set upon the fill. The intention is to let this construction stand for a year or two until the bank has become thoroughly settled and compacted, and then to drive concrete piles and build the permanent concrete abutments.

For the channel span towers the piers are of reinforced concrete. This construction was adopted in this case in order to withstand the stresses imposed by the longitudinal and lateral thrust of the trains. Another point of interest in connection with the concrete here is one that applies to all pier construction on the line. The piers are built about ¾ in. high and the material is allowed to harden. It is then bush hammered down to exact heights. The result of this is that far more accurate work is obtained than is possible where an attempt is made to build to exact height in the first place. The latter frequently results in the necessity for shimming one leg or another of a tower or permitting it to stand slightly out of line. The accuracy that is obtained with this method is exemplified in the case of the Copper creek viaduct, where every tower stands so exactly plumb that any existing error is so slight that it cannot be detected by the most carefully adjusted transit. The method costs a little more for the concrete and its dressing, but this extra expense is more than saved by the avoidance of all adjusting schemes in the erection, and in the assurance that all parts will be in place as designed.

These examples of bridges are given as typical of those that will be used on the line, and as showing the wide range of structures demanded by a line running from the mountain district of steep slopes and narrow valleys with swift streams liable to a sudden rise to the open country of the south.

TIMBER TRESTLES.

As an auxiliary to the regular bridge and viaduct construction, it is frequently necessary to use timber trestles for temporary structures or for branch line spurs. Although nothing of this sort will enter into the permanent structure of the road, certain standards have been adopted. These are arranged as one, two, three and four-story bents, and are shown in outline. In detail they do not differ essentially from those used elsewhere, except in the strength which is calculated, like all of the permanent bridges, for the Cooper E 60 loading. The same rule is also applied in the matter of

footwalks and railing, but the method of caring for the superelevation of the outer rail is different. On the wooden trestle an inclined filler is laid directly on the cap of the bent and the stringers are bolted on top of it. This gives their top surfaces the proper inclination for the ties, which are bolted directly to them. It will be noticed, too, that the filler, besides being spiked to the cap, is held in place at the thick end by two 12-in. plates spiked in place.

Ordinarily, the feet of the posts will be carried by concrete piers put beneath the sills, but occasionally a timber grillage may be used. Where the trestle stands on a curve that is sharper than 1 deg., a continuous pier extending the whole length of the sill will be used. In order to protect the timber from dampness, all of the caps and stringers are covered with No. 26 galvanized iron that is lapped down over the vertical faces for 2 in. and nailed. For protection against fire, four ties are carried out 4 ft. beyond the guard timbers, at intervals, for the support of water barrels. It thus appears that though these trestles are considered as auxiliaries, the same provision has been made in their design as though they were to be permanent.

HIGHWAY CROSSINGS.

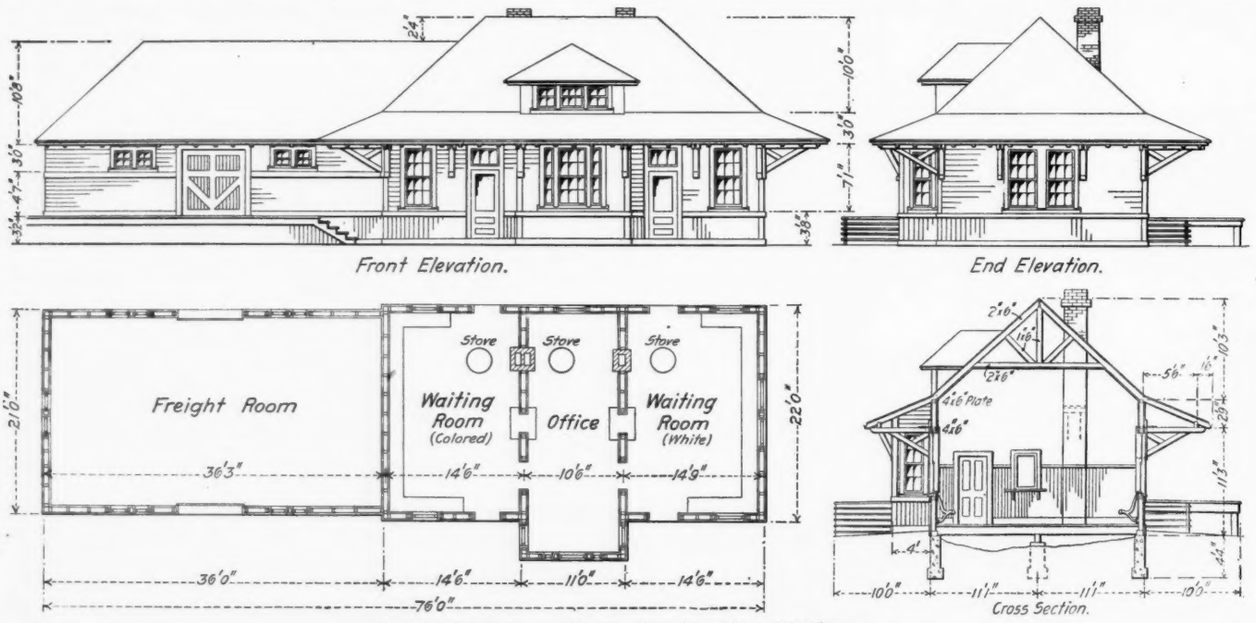
Closely allied to the bridges for carrying the road are those for the overhead highway crossing. In this construction it has first been taken into consideration that the country is new; the wagon roads are about as bad as they can be and still be passable, and the traffic upon them is correspondingly light. It is therefore unknown what the demands of the future may be, and it has been decided to await developments before erecting expensive bridges.

The first bridges of this character, therefore, that have been built have been of wood like those shown in the illustration. The design is exceedingly simple, and can be seen by a glance at the engraving. Attention is merely called to the liberal lateral clearance of 27 ft. between bents supporting the towers, and the height of 22 ft. 6 in. from the base of the rail to the clearance plane of the structure. With this overhead clearance there is no danger to a man on the top of the ordinary box car.

If, however, road traffic develops at any point so as to warrant the construction of a better structure, provision has been made for it in the designs of a standard steel overhead highway bridge. This bridge is for a span of 76 ft. 8 in., which is that corresponding to a clear height of 22 ft. 6 in. above the rail and spanning the distance between cut slopes of 1 to 1½. It is calculated for a dead load of 400 lbs. per lineal foot of truss, and a live load of 100 lbs. per sq. ft. of floor, with a roadway of 14 ft. in the clear. None of these bridges has been built as yet, and it is not likely that there will be for some time to come, until highway traffic finds itself.

STATIONS.

From the outline of the country that has been given, it is evident that there are no large towns upon the road. As it stands, it runs from the little village of Dante, Va., to the imperceptible one of Bostic, N. C., only touching one of any size at Johnson City, Tenn., a place of 6,000 inhabitants. Hence no provision need be made, at present at least, for any very elaborate station facilities. Yet it is necessary that there should be something, and at a number of points there are indications that a considerable traffic will be handled. In order to meet these conditions, a simple country station building has been designed. It is a frame structure 76 ft. long and 22 ft. wide. It has the usual separate racial wait-



Standard 22 ft. x 76 ft. Combination Station.

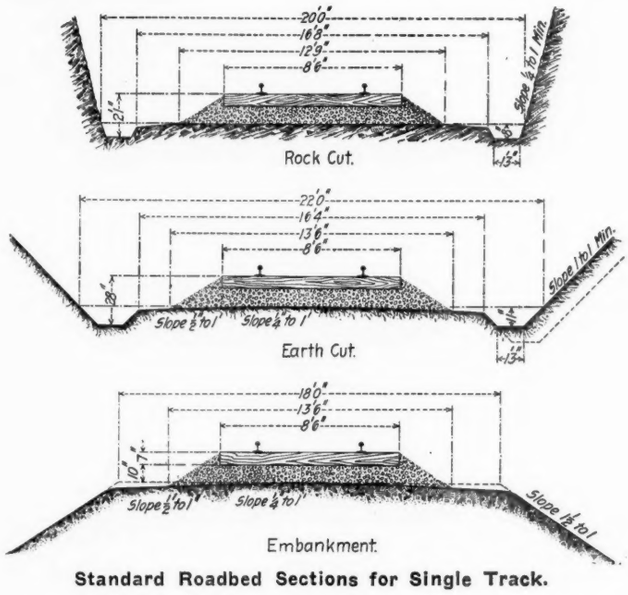
ing rooms of the South, each 14 ft. x 20 ft., with an office having a bay window and extending across the building between the two. These three rooms occupy 40 ft. of the length, and the remainder, 36 ft., is occupied by a freight room with wide doors at front and back. Along the three outside walls of the freight house there is an elevated platform for loading. The main building is 14 ft. high to the eaves and 24 ft. 3 in. to the ridge pole, and has an overhanging shelter around the passenger end of the station. It is simple in design and will probably be used at all small stations where it is found necessary to erect a building.

TRACK.

In order to make such a road as that described efficient, a good track is of course a necessity, and this is being provided as rapidly as possible. The road is new, and the work of raising settled places in the fills, cleaning ditches and draining cuts is being pushed as rapidly as possible. At present there are five rock crushers (three main and two auxiliaries) at work, with a capacity of 1,500 cu. yds. of rock ballast per day, which is to be used for the whole length of the line, at the rate of about 1,000 cu. yds. to the mile for the first lift. In places where the cuts are wet and soft, a regular Telford construction is being put in; that is, large stones are laid upon the sub-grade to raise it to line, and finer stone on this for ballast to carry the track. The standard cross section of the track calls for a crowned roadway with a slope of ½ in. to 1 ft. from the ends to the ties to the edge of the berm with crowning slope of ¼ in. to 1 ft. from the ends of the

ties to the center of the track. There is 10 in. of stone ballast below the ties, and these are 7 in. thick. While the standard width of fills is 18 ft. at sub-grade all structures are designed for a corresponding roadbed width of 20 ft.

The rail weighs 85 lbs. to the yard, and is carried in the standard first-class track by 18 ties for a 33-ft. rail, whose



Standard Roadbed Sections for Single Track.

joints are staggered and of the suspended type, with Bonzano continuous and other forms of improved joints. For second-class track on spurs and sidings, only 16 ties are used for a 30-ft. rail, which in reality makes but little difference in the spacing, as compared with the first-class track.

For track laying, the instructions are to lay the heart side down and select the best ties for joints, and that in laying them there shall not be less than 6 in. between adjacent faces and that their ends on the west side of single track and the outside of all double track shall be in line. It is required that the spikes shall be driven vertically, not less than 2½ in. from the edge of the ties, and on the same side for all outside spikes and on the opposite side for the inside. For the rail-laying the following schedule has been adopted:

Allow	5/16	in. open	joints	for temperature of	5°	below zero
"	1/4	"	"	"	20°	above zero
"	3/16	"	"	"	45°	"
"	1/8	"	"	"	70°	"
"	1/16	"	"	"	95°	"
"	0	"	"	"	120°	"

Tie plates are used on all bridges and on all curves above 3 deg. The maximum superelevation allowed is 5 in., which corresponds to speeds of 30 and 40 miles an hour on 7 and 6 deg., respectively, although speeds of 35 and 45 miles per hour will be allowed. For sharper curves, the speed will be reduced to 30 miles. In this superelevation the grade line is maintained along the inner rail, and the superelevation obtained by raising the outer one. In case a permanent structure establishes the elevation of the outer rail, the same is maintained on the adjoining curved track. As all curves have a spiral approach at each end, the elevation at the point of the spiral is zero and increases proportionately with the spiral until the required elevation is reached at the point of the spiral curve. The spirals are laid out in accordance with Sullivan's tables, based on Crandall's formula using 35-ft. chords.

For the cuts and fills, a minimum slope of 1½ to 1 is prescribed, though in places the inclination is much less than this owing to the soft and flowing nature of the material. In the case of wet cuts, the ditches are being tiled, and in all cases an intercepting ditch is dug back of the crest of the cut to carry off the water and protect the slopes from wash and erosion. In this way the bed is kept dry, even in places that would otherwise be very wet. Where the road has been completed over settled or rock bed it is already in first-class shape for heavy traffic at high speeds.

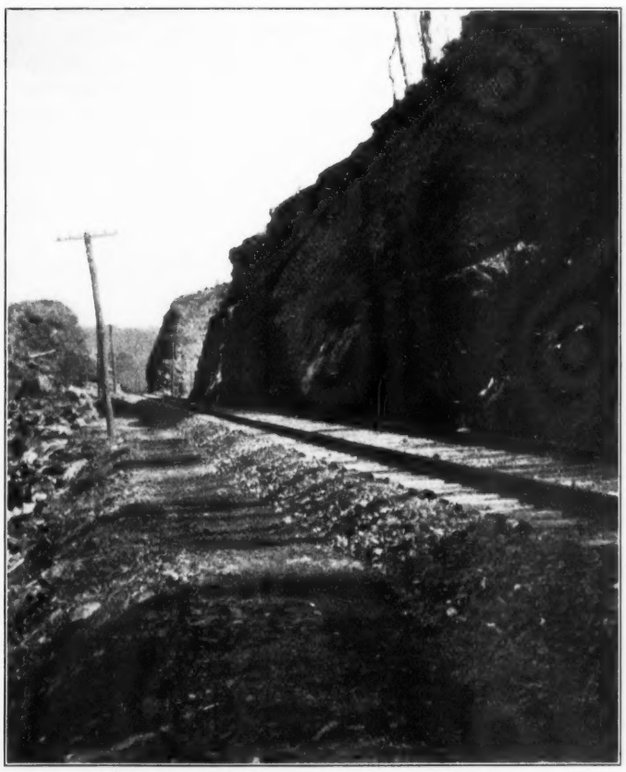
As the road is a single-track line and a traffic with long and heavy trains is expected, ample provision is made all along for passing sidings of the standard length of 4,400 ft., though in a few isolated instances the local conditions have been such that it has been advisable to depart from the standard and use shorter lengths.

FREIGHT CARS.

It is probably quite superfluous to say that on such a road as this the 50-ton capacity car is to be the standard and that it will be of steel. There will be four types of these cars: a flat, a flat bottom gondola with twin hoppers, a hopper bottom gondola, and a box car with steel underframing and wooden superstructure. In these, all of the underframings are built up of shapes, and no pressed steel sills are used at all. All cars have Schoen steel wheels.

The flat cars will have a length of 40 ft. and a width of 9 ft. over the sills, and will weigh, inclusive of trucks, 38,780 lbs. The flat bottom gondolas have the same length but are 7 in. wider and weigh 41,300 lbs. The hopper bottom gondolas are only 31 ft. 6 in. long; are 9 ft. 6 in. wide, and weigh 36,400 lbs. All are rated at 100,000 lbs. capacity, with the possibility of the usual 10 per cent. overload. The cars are of standard types and designs that have been used elsewhere and present no novel features of construction.

For passenger equipment the road has taken a stand with the most advanced. All baggage, express and postal cars will be of all-steel construction, while the passenger coaches will have steel underframes with wooden superstructure. Shapes and built-up sections will be used, to the exclusion of pressed



Track and Ballast.

shapes, the cars being built in accordance with the designs in use on the Pennsylvania Railroad.

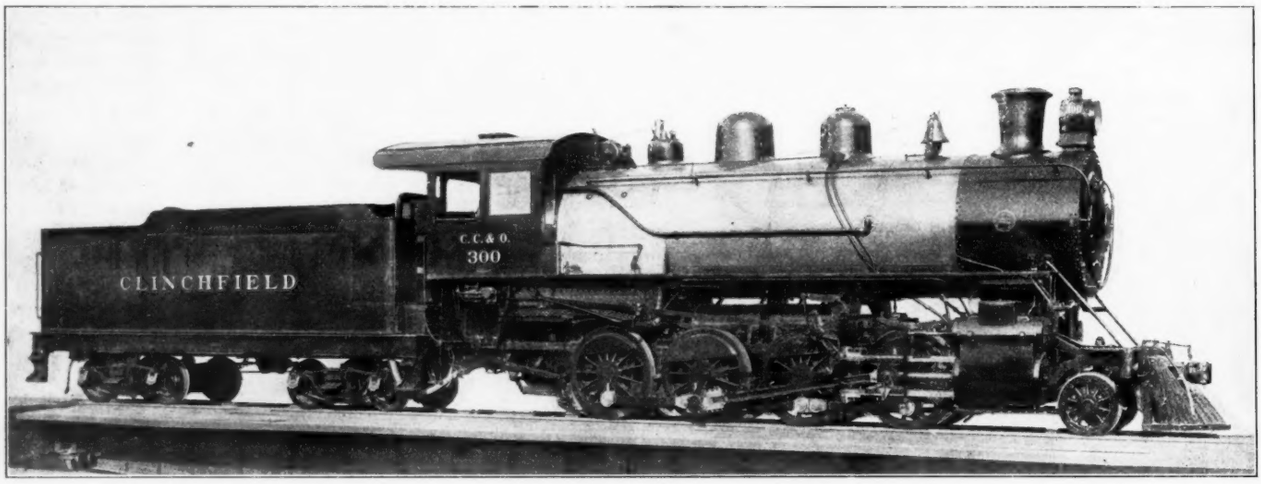
LOCOMOTIVES.

With a low-grade line for heavy traffic the motive power must also be in harmony therewith. At present the standard locomotives are 10-wheel and consolidations, the former for passenger and the latter for freight service. Those now being received, illustrations of which are given, are not intended as

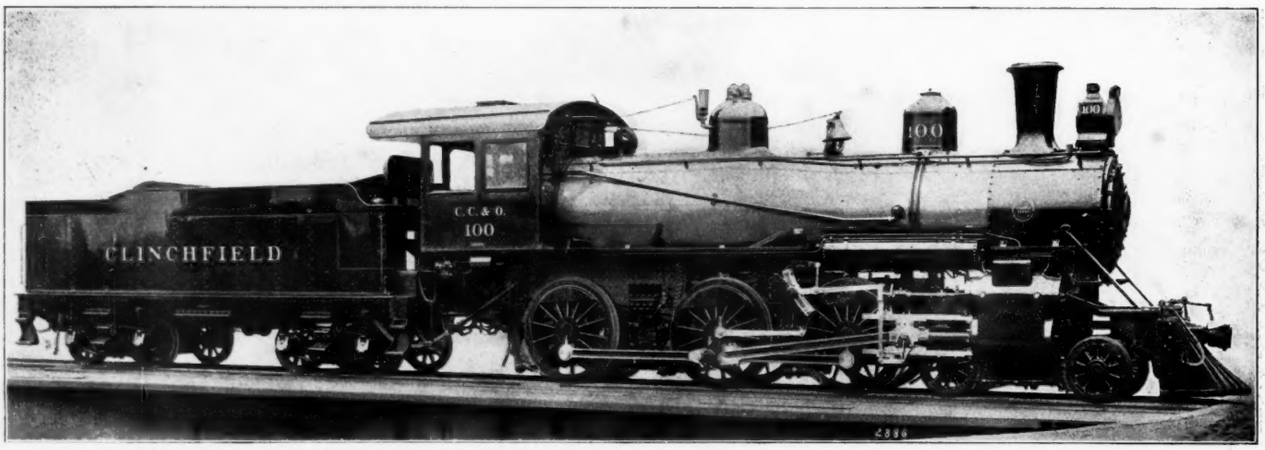
permanent standards, but are regarded as a light type that will be replaced by heavier ones as soon as the fills have settled and are capable of supporting heavier wheel loads. The present consolidations weigh nearly 200,000 lbs., of which 178,650 lbs. are upon the drivers. It was the intention to replace these by others similar to the old Bessemer engines, weighing 250,000 lbs., of which 225,000 lbs. are upon the drivers; but upon more mature consideration it is thought probable that Mallet articulated compounds will be used, similar to those built by the Baldwin Locomotive Works for the Great Northern Railway, which were illustrated in the *Railroad Age Gazette*, Dec. 18, 1908. One of these engines has been ordered for trial, and if it proves satisfactory for the long haul of about a hundred miles over the Blue Ridge, the type will be used for regular road service instead of the consolidations referred to. These engines will be duplicates of those built for the Great Northern, except that the diameter of the driving wheels will be increased from 55 in. to 57 in., and certain other details, such as driving and truck boxes, will be changed so as to be interchangeable with those of the engines already in hand. It is for this reason that the diameter of the drivers has been changed, as 57 in. is that adopted for the consolidations, and it is desired to have uniformity and interchangeability as far as possible. This same idea has been carried out in the designs of the 10-wheelers and consolidations, and as many parts as possible have been made interchangeable on the two types of locomotives. These include the injectors and all of the cab fixtures, the truck wheels, driving and truck boxes. The firebox is wide and is carried at the back by the usual buckle plate and rests at the front on a cast steel shoe that slides in a seat bolted to the frames. The engines are built with cast steel frames, and have the cylinders cast with half saddles. They are fitted with air bell ringers, the Westinghouse ET6 air-brake, and an 8½-in. cross compound pump. The front end is arranged to be self-cleaning.

The following are some of the principal dimensions of these engines:

	Consolidation 2-8-0.	10-Wheel 4-6-0.
Cylinder, diameter	22 in.	20 in.
Piston, stroke	32 "	26 "
Boiler, diameter	76¾ "	60 "
Boiler, thickness, sheets	11/16-in.	5/16 and 5/8-in.
Steam pressure	190 lbs.	190 lbs.
Firebox, length	108 5/16 in.	120 5/8 in.
" width	71¾ "	40 "
" depth, front	74½ "	73 "
" depth, back	65½ "	62 "
" thickness, sides and crown	3/8 "	3/8 "
" " back	5/16 "	5/16 "
" " tube	½ "	½ "
" water space, front	5 "	5 "
" water space, sides and back	4 "	4 "
Tubes, material	Steel	Steel
" thickness	11 in.	11 in.
" number	412 "	295 "
" diameter	2 "	2 "
" length	15 ft. 3 in.	15 ft. 3 in.
Heating surface, firebox	182 sq. ft.	174 sq. ft.
" " tubes	3,272 "	2,343 "
" " fire-brick tubes	28 "	...
" " total	3,482 "	2,517 "
Grate area	54 "	33.3 "
Wheels, diameter, driving	57 in.	63 in.
" " truck	33 "	33 "
" " tender	33 "	36 "
Journals, main driving	9½ in. x 13 in.	9 in. x 13 in.
" other driving	9 " x 13 "	9 " x 13 "
" truck	6½ " x 12 "	6½ " x 12 "
" tender	5½ " x 10 "	5½ " x 10 "
Wheel base, driving	16 ft.	15 ft.
" " total engine	24 " 6 in.	26 " 5 in.
" " engine and tender	56 " 9½ in.	59 " 8¾ in.

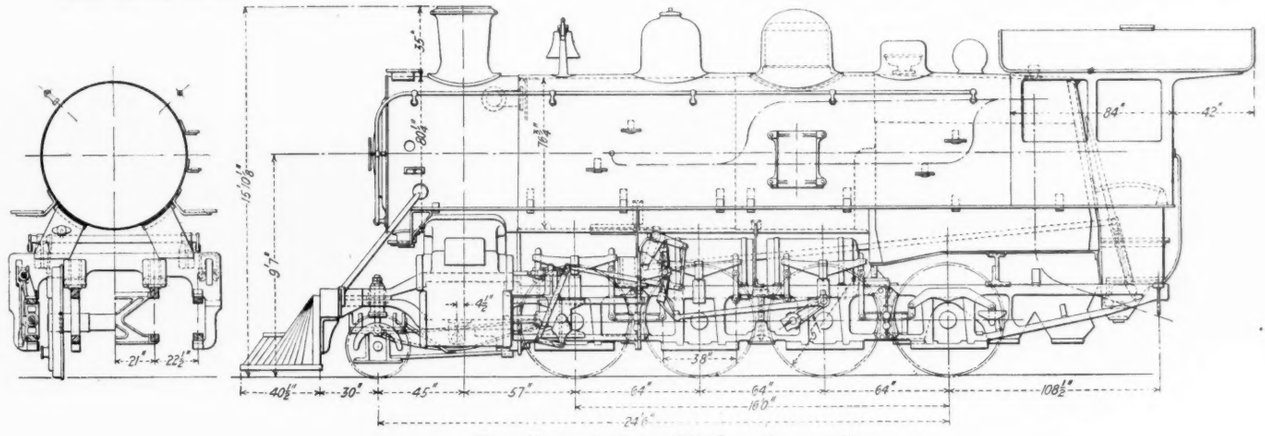


Consolidation Locomotive; Carolina, Clinchfield & Ohio.

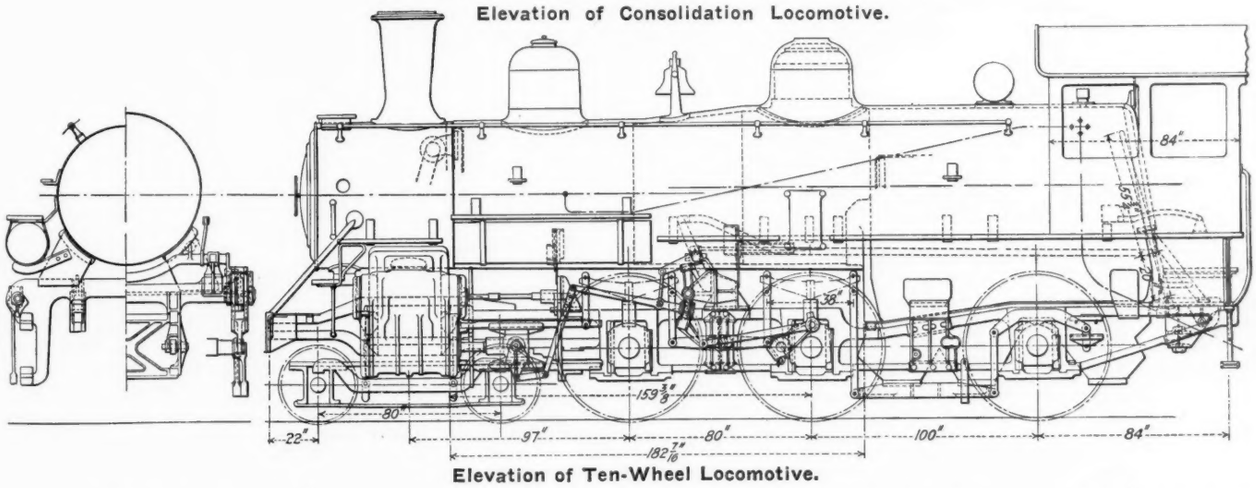


Ten-Wheel Locomotive; Carolina, Clinchfield & Ohio.

	Consolidation 2-8-0	10-wheel 4-6-0
Weight on driving wheels	178,650 lbs.	125,300 lbs.
" on truck wheels	20,500 "	38,300 "
" total engine	199,150 "	163,600 "
" engine and tender, about	350,000 "	284,000 "
Tank capacity, water	7,500 gals.	6,000 gals
Tank capacity, fuel	12½ tons.	12 tons.
Tractive effort	43,882 lbs.	26,660 lbs.
Weight on drivers / Total weight	89.5*	76.6*
Weight on drivers / Tractive effort	4.07	4.69
Total weight / Tractive effort	4.54	6.13
Tractive effort x diameter drivers / Heating surface	718.34	667.29
Heating surface / Grate area	64.48	75.58
Firebox heating surface / Total heating surface	5.22*	6.91*



Elevation of Consolidation Locomotive.



Elevation of Ten-Wheel Locomotive.

	Consolidation 2-8-0		10-wheel 4-6-0	
Weight on drivers / Heating surface	51.30		49.78	
Total weight / Heating surface	57.19		64.99	
Displacement of 2 cylinders / Heating surface	14.08	cu. ft.	9.45	cu. ft.
Heating surface / Displacement of 2 cylinders	247.30		266.34	
Grate area / Displacement of 2 cylinders	3.83		3.52	

*Per cent.

SHOPS.

At present the facilities for shop and engine work are meager, but large shops are being erected at Erwin, and will be pushed to completion as rapidly as possible. In this connection attention is called to the large size of the turntables that are being installed. While the wheel base of the longest of the locomotives at present in service is less than 60 ft. and a 75-ft. turntable would be of ample length, provision is being made, not only to take the Mallet compounds that will be used and will have a wheel base of nearly 74 ft., but for future growth, and 100-ft. turntables will be used.

The table itself is of the usual plate girder design. It is supported on a central concrete pier 17 ft. square and carried down to firm earth. It is pyramidal in shape and is 6 ft. square at the top to receive the table center. In the foundation a 1-3-6 mixture is used which is changed to a 1-1-2 at the top.

The pit is paved with brick, and there is a steel curb at the edge. The wall is of 1-3-6 concrete, reinforced at the bottom with rails laid en grillage 6 in. apart. The curb is protected by 10-in. 35-lb. I beams and an inverted T rail is embedded in the concrete to give a firm bearing to the running rails.

WATER.

In connection with the locomotive work a great deal of pains is being exercised in the selection of the water to be used and the location of the tanks. Analyses are made of all waters that are considered and those are discarded that are impregnated with scale forming properties to any extent. This is possible to an extent in the south where the waters are pure, that could not be done elsewhere. Occasionally water is found that contains 18 or 19 grains of incrusting material to the gallon, but these are promptly discarded for others with less. Indeed, 7 grains of incrusting matter to the gallon is the worst that will be used, although it does not seem probable that it will be necessary to go as high as that. There are some analyses that show as low as 0.0816 grains of incrusting matter, and these, with those running up to about 4 grains, are the ones that will be used.

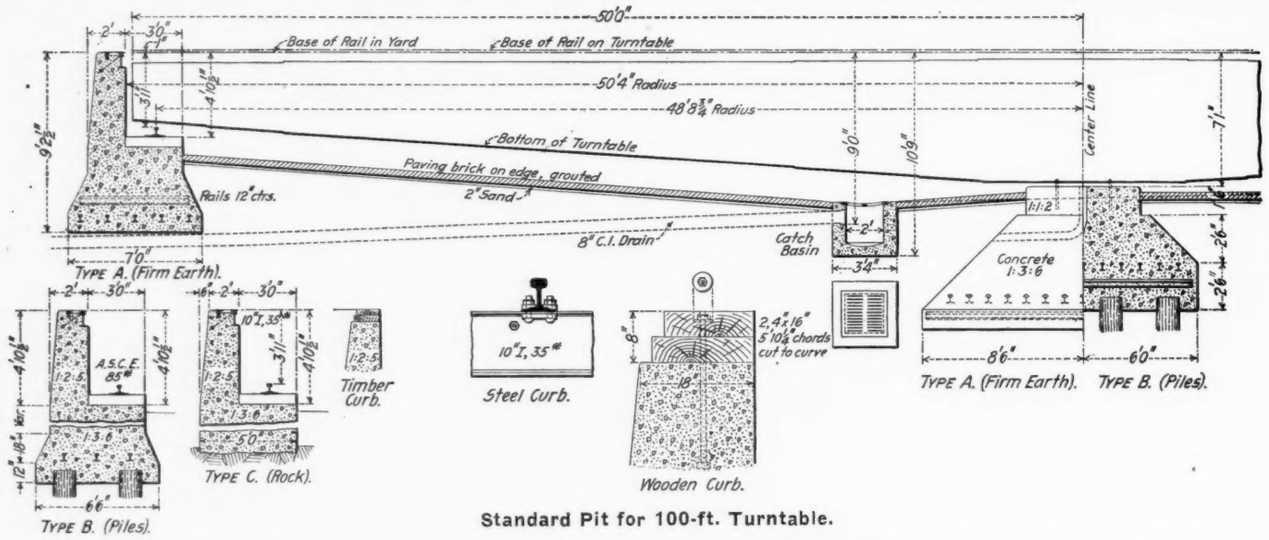
Owing to the hilly nature of the country these waters will, for the most part, be piped down from above so that the tanks will be fed by gravity and pumping stations be dispensed with. In one case, at the summit of the Blue Ridge, a very pure water has been obtained which contains only about one-half grain of incrusting matter to the gallon. This water will be piped down the side of the mountain for four miles to a tank

400 ft. below. This is the longest run on the road, but serves to indicate the pains that are being taken in all details to hold everything up to the high standard that has been set by the location and general construction.

TRAFFIC.

What are the prospects that this costly road, built from the small mining village in southwestern Virginia to Spartanburg, S. C., without a single large town *en route*, can be made to pay? And further, what inducements can be offered to extend it further to the north to Elkhorn City, Ky., on the Big Sandy river, to a connection with the C. & O. Railway, through a territory as heavy and difficult as any that has been traversed by the southern section?

The answer is "Coal." Careful investigations have been made during the past few years as to the coal consumption in the territory to which the road is tributary, and it has been found to be about 6,000,000 tons annually for the two Carolinas and as much more for Georgia and Florida. The rate of increase has been about 8 per cent. per annum and it is estimated that had transportation facilities from the coal fields been adequate this increase would have been at least 10 per cent. Up to the present the supply has come from the Alabama district, which is the nearest as well as from the eastern Tennessee mines and those of West Virginia. In the latter case, the coal goes east over the Norfolk & Western to Roanoke and then south to Winston-Salem for distribution further on, while the New river product goes east over the Chesapeake & Ohio to Lynchburg and Petersburg and thence south over the Atlantic Coast Line. From the Alabama fields there is the direct eastern connection to Savannah and Charleston. This appears like a strenuous competition until it is analyzed.



Standard Pit for 100-ft. Turntable.

Suppose now, we take the actual distances to be hauled from the several assembling points in the different fields to the large centers of the South. Take Columbia, S. C., and Wilmington, N. C., as examples. From Bluefield, on the Norfolk & Western, to Columbia, via Roanoke, Winston-Salem, over the Southern and the Atlantic Coast Line, it is 420 and 498 miles to Columbia, S. C., and Wilmington, N. C., respectively. From Hinton, on the Chesapeake & Ohio, to Columbia, via Lynchburg and the Southern Railway and Wilmington via Richmond and the Atlantic Coast Line, it is 479 and 557 miles, respectively. Then from Birmingham to Columbia it is 405 miles. As against these figures, the Clinchfield route has 337 miles from Dante to Columbia and 476 miles to Wilmington. Therefore, if the quality of the coal is the same, the traffic balance should be in favor of the new line.

It is, of course, difficult to find a coal equal to or superior to that of the great Pocahontas seam, with its 7 per cent. of ash and 70 to 80 per cent., or even more, of fixed carbon, but comparatively little of this coal goes south, as the demand at the coast takes a large percentage of the output. The New river coal ranks next, with about 75 per cent. fixed carbon and 7 per cent. ash, while the Birmingham coal comes last in the list with 62 per cent. carbon and 8 per cent. ash, to which a high sulphur content must be added. The coal that the Clinchfield will carry into the south in competition with these, ranges from 62 per cent. carbon and 6.35 per cent. ash, in the Lower Banner seam, to 74 per cent. carbon and 3.5 per cent. ash in the Imboden seam, developing 14,631 and 15,576 British thermal units per pound, respectively. From this it appears that the coal is at least capable of holding its own with that now on the market.

With a good road and a good coal, it then remains to discuss the quantity in sight and the facilities for mining. The property is situated in Dickenson county in the southwest corner of Virginia, though Dante is in Russell county. The operating company, the Clinchfield Coal Corporation, owns about 250,000 acres, or practically a whole county. Its present yearly output is about 650,000 tons, which has been marketed for the past five years over the Clinch Valley division of the Norfolk & Western. Extensive improvements are being made upon the property. New openings in the outcrop are being made, tipples are being built, and the valley of Lick creek is being developed with extensive sidings and switchback approaches to the mines. It is the intention of the company to extend these facilities as rapidly as the work can be done, and it is hoped that by January 1, 1910, the output will be at the rate of 2,000,000 tons per year, and that this can steadily be increased until it amounts to from 6,000,000 to 10,000,000 tons. It is estimated that the seams on the property, now known to exist, contain at least 1,000,000,000 tons. This is deposited in six seams. The upper, known as the Edwards or Clintwood, ranges from 4 ft. to 9 ft. in thickness. About 400 ft. below this is the Upper Banner, from 3 ft. 10 in. to 9 ft. thick, with an average of about 5 ft. Below this by from 100 ft. to 140 ft. is the Lower Banner, averaging 4 ft. thick. Then 240 ft. lower comes the Widow Kennedy, a wavy seam, uncertain in the amount contained and having a thickness running from ¼ in. to 14 ft. These are all outcropping seams that are above the surface. About 200 ft. below the surface at Dante there is the Imboden, a high grade coal with a seam running from 4 ft. to 19 ft. and averaging about 6 ft. Then, last of all, and from 90 to 100 ft. lower, is the Jawbone, from 2 ft. to 6 ft. thick. All these seams have a dip to the northwest on an inclination of about 1 deg., in common with all of the other coals of the region. Below them all is the great Pocahontas seam, and it is estimated that if the thinning of the seam and the dip that is known to exist at Pocahontas on the Norfolk & Western, hold down to southwestern Virginia at the same rate, the seam exists at from 1,200 ft. to 1,300 ft. below the surface at Dante, and is there about 6 ft. thick. This is a surmise, and borings are to be made to determine its truth or

falsity. If it is found, it will add many million tons to the quantity given above.

As these coals are new upon the market and are not yet well known, the following analyses are given as an indication of the quality.

	Upper Banner.	Lower Banner.	Widow Kennedy.	Imboden.
Moisture	1.16	2.00	2.25	1.02
Volatile combustible	31.39	29.12	25.22	21.05
Fixed carbon	63.22	62.53	65.22	74.76
Ash	4.23	6.35	7.31	3.17
Sulphur	.72	.82	1.51	.61

These analyses are good indications of the rise in the quality of coal as we go to the lower seams, because of the greater pressure and age, as well as the more thorough coking to which it has been subjected.

Not only is this coal well adapted to steam purposes but it cokes well and compares favorably with the Connellsville standard. In a recent report on the subject, Prof. Andrew S. McCreath said that after an examination of 48-hour cokes made in beehive ovens from Upper and Lower Banner coals, he found that the Upper Banner "is a bright, hard-bodied coke, equal in its physical properties to the standard Connellsville coke. In its cellular structure, from the freedom secured in the beehive oven, it is disposed to finger structure, with slight shattering conditions. The coke from the Lower Banner seam is somewhat firmer than its associate. Both cokes exhibit good coking work, especially in these 48-hour cokes. Both samples present the bright, silvery glaze which distinguishes the Connellsville standard variety. These cokes are equal to the standard in appearance. In physical properties they are nearly equal to the best Connellsville coke. In hardness of body, which is one of the principal requirements in blast furnace coke, they are equal to the best coke. Their cellular structure assures rapid combustion in the blast furnace. In sustaining the charges burden in blast furnace work, they approach very closely to the best standard and excel the Pocahontas variety. In chemical purity they stand between the Connellsville and the Pocahontas. The content of sulphur is very moderate."

The analyses of the four cokes under consideration are as follows:

	Connellsville.	Pocahontas.	Upper Banner.	Lower Banner.
Moisture	0.42	0.345	....	....
Volatile matter	0.80	0.341	1.735	1.886
Fixed carbon	87.46	92.694	87.711	87.407
Ash	11.32	5.882	9.660	10.095
Sulphur	.69	0.738	0.892	0.612
Phosphorus	.015	0.0063	....	....

"The general average will compare very favorably in physical and chemical properties, with the standard Connellsville, and superior to the Pocahontas coke in physical properties."

This, in brief, is an outline of the sources and amount of traffic that this new road can expect to handle, in a direct southern coal trade, without any regard to the outlet to the north that will be effected as soon as the line is opened from Dante to Elkhorn City. When this has been accomplished, it is estimated that there will develop a large through merchandise traffic, which has been placed as high as $3,000 per mile per year.

PASSENGER TRAFFIC.

The local business will undoubtedly be light for some time, but when it is considered that this will be the shortest line between Cincinnati and points in North Carolina, South Carolina, Georgia and Florida, besides offering scenic attractions that are not equaled by any other route, it is a reasonable expectation that passenger traffic will eventually develop into considerable magnitude.

SUMMARY.

The Clinchfield line will originate the great bulk of its own traffic. It depends upon a commodity in constant and growing demand throughout the territory it serves, which it expects to handle successfully in competition with its neighbors, because its location is that of a first-class, low-grade modern railway capable of hauling a heavy tonnage in large units at a minimum cost.

THE WESTERN PACIFIC.*

BY P. S. HILDRETH.†

Any important railway construction develops new conditions and methods of meeting them which are of interest, and the Western Pacific, now approaching completion, is particularly worthy of note because of the initial high standard of construction work on which the entire line is being built. Probably no railway, before or since the West Shore, has originally been as well located and substantially constructed, and these methods are certainly new to western railway building. Exceptional study has been given to location to secure the best of what will permanently affect the success of the enterprise, including grade, alinement, ample facilities at terminals and conditions forming permanency of roadbed and assuring economy of operation.

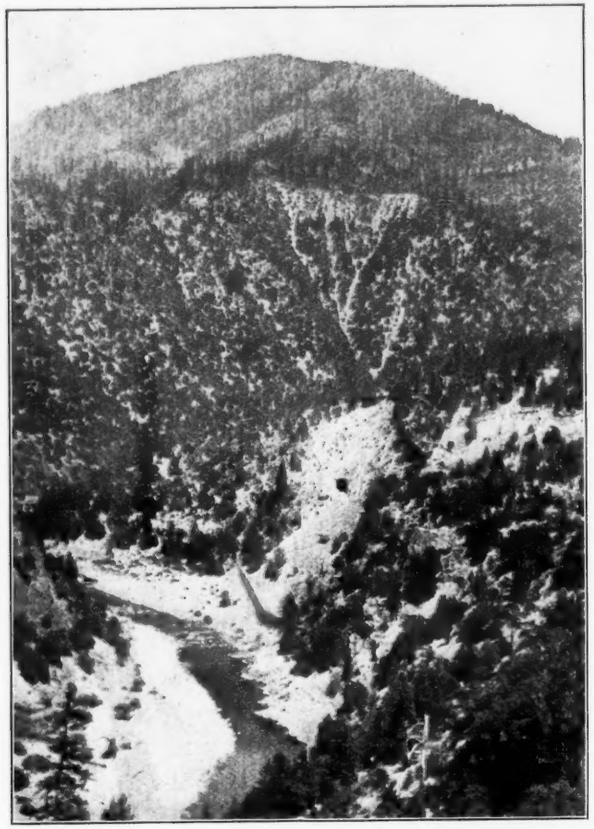
ROUTE.

The Western Pacific is an extension of the Denver & Rio Grande System, west from Salt Lake City to San Francisco, 927 miles, connecting the Gould system with the Pacific Coast and the Orient. From San Francisco, its terminal on the west, ferry connects with Oakland (3.5 miles) from which the line runs southeast to Niles (29.6 miles) and then east through the Niles canyon and over the summit of the Coast range at Altamont (55.9 miles) to the crossing of the San Joaquin river, avoiding the tule beds and low land to the north; then due north in the valley of the Sacramento through Stockton (93.7 miles), Sacramento (138.5 miles), Marysville (179 miles) and up the Feather river valley to Oroville (204.9 miles). A few miles north of Oroville, the railway enters the canyon of the Feather river and begins the climb of the 1 per cent. grade, which is the maximum grade on the road and from Bloomer Siding (218.9 miles) is continuous for almost 100 miles. On entering Plumas county the direction changes to the east, following the North Fork of the Feather river and then the East Branch, Spanish creek and Spring Garden creek (293.7 miles) then crossing a divide through Spring Garden tunnel (297.2 miles) 7,306 feet long, to the valley of the Middle Fork. At Spring Garden tunnel, the elevation is 4,043 feet and for about 20 miles before reaching the tunnel and 30 miles thereafter several rich valleys in the Sierras are crossed. Just before reaching the tunnel, development work is necessary to maintain the 1 per cent. maximum grade. This is accomplished by a loop, known as Williams Loop. At Mile Post 314.4 the line crosses the Willow creek viaduct, the highest steel structure on the line, 175 feet high and 1,340 feet long. Four miles beyond is reached the head of the 1 per cent. grade (318.7 miles). Still running east the line crosses the Continental Divide at an elevation of 5,018 feet at Beckwourth Pass by the Beckwourth tunnel, 6,006 feet long (340.4 miles). Immediately after leaving this tunnel the line turns due north and runs to Honey Lake, then east again, crossing into Nevada, and northeast across Smoke Creek Desert, Granite Creek Desert and Black Rock Desert to Deep Hole (430.3 miles), then due east to Winnemucca (532.2 miles), where it reaches the valley of the Humboldt river adjacent to the Central Pacific Railway. From Winnemucca it follows the Humboldt river valley, in sight of the Central Pacific, to Wells (717.1 miles) then turns southeast to Flower Lake Pass, which is crossed through the Flower Lake Tunnel, 5,657 feet long (753.7 miles), then northeast to Silver Zone Pass, crossed by another ingenious development, where a horseshoe curve, five miles long, on a 1 per cent. grade, takes the place of what would, if a direct route were followed, be a 3 per cent. grade. Thence the line runs southeast to Wendover (806.7 miles) at the western edge of the Great Salt Desert. From Wendover the line is run

*An article dealing with the traffic conditions of the Western Pacific appeared in the *Railroad Age Gazette* September 11, 1908. In a later article, the standards of construction will be illustrated.

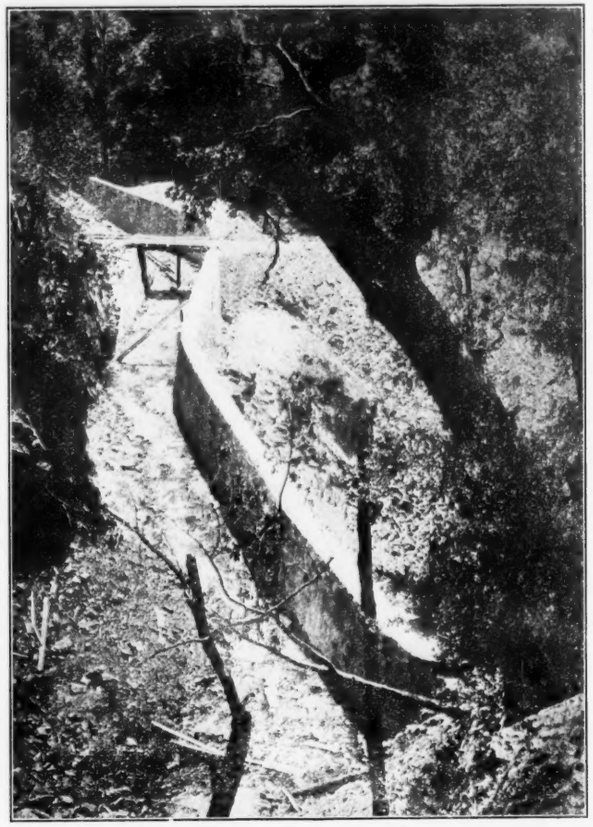
†Inspecting Engineer for the bankers.

Oakland Terminal, with Southern Pacific Terminals on Either Side.

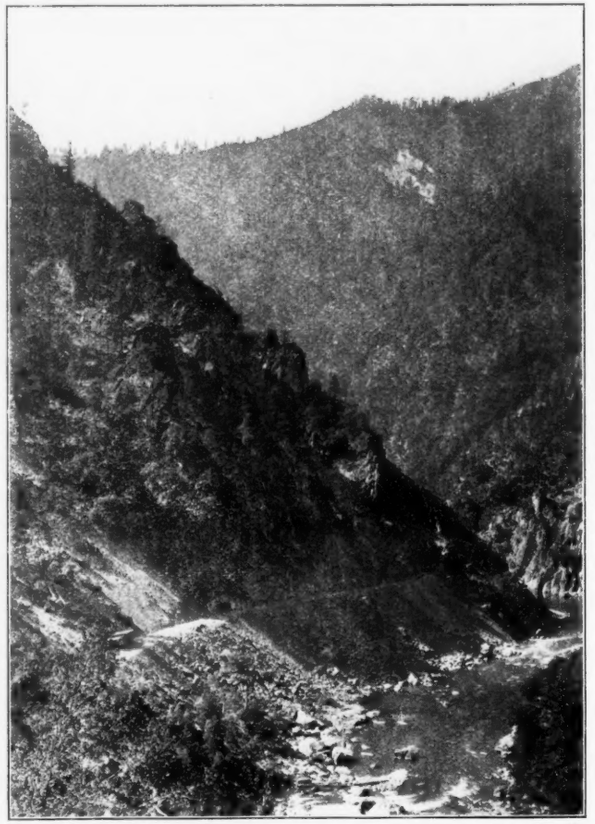


West Portal of Smith Point Tunnel.

Short tunnel through shoulder of hill. Crib-work protection at foot of embankment.



Deflection of Stream.

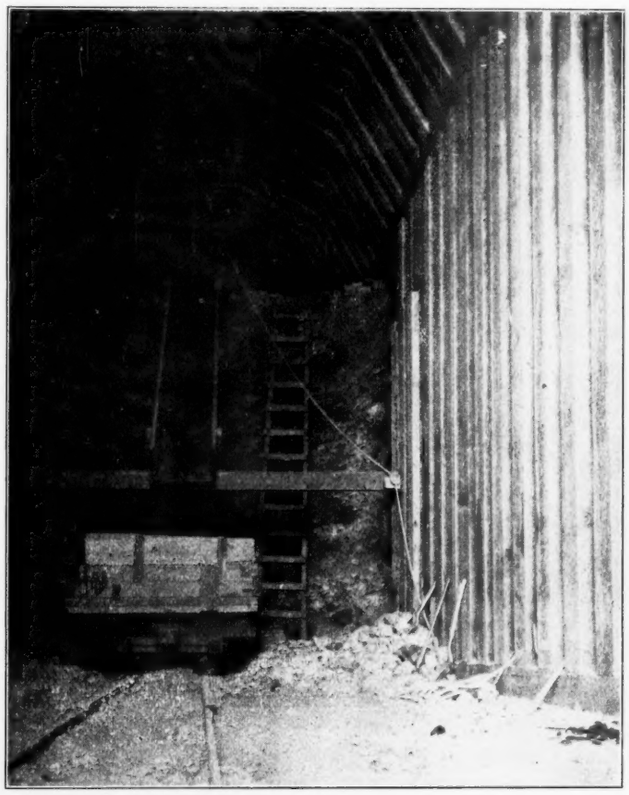


Eagle Point.

on a tangent of 43 miles to Knolls (845.2 miles) on the east edge of the desert, then generally easterly to the southern end of Great Salt Lake near Grants (696.9 miles). It then crosses the lake in shallow water for seven miles and follows the shore of the lake to Garfield (913.2 miles) and thence directly east to Salt Lake City.

LOCATION.

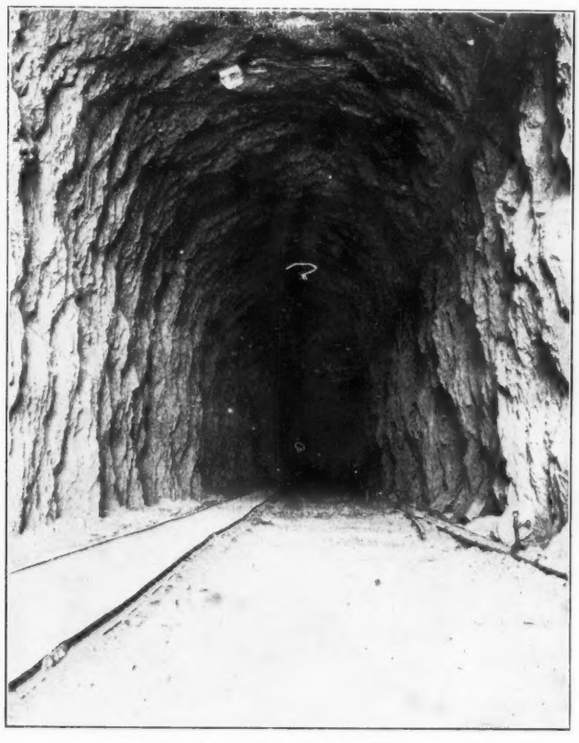
The drainage of the Feather river was considered by Mr. Judah when locating the Central Pacific and he made an



Timber Lined Tunnel.

examination of the Middle Fork. The excessively heavy character of the work and the time necessary to construct undoubtedly led him to abandon such a route. In 1866, A. W. Keddie, for many years County Surveyor of Plumas county, and connected with the Western Pacific during location and construction as Assistant Engineer, made a reconnoissance down the canyons to Oroville for a wagon road from the Sierra valleys, which could be used in winter. He found that by following the North Fork he could get a low grade and that the snow line was above the bottom of the canyons, whereas on the Middle Fork there were two feet of snow. In 1869 a company, known as the Oroville & Virginia City Railroad, employed Mr. Keddie, and he made a location down the North Fork, getting a grade of 65 feet to the mile. This survey was being made at the time the Central Pacific was opened. In 1892 W. H. Kennedy, acting for the San Francisco & Great Salt Lake Railroad, conferred with Mr. Keddie and located a line down the North Fork on a grade of 1.36 per cent. Two of the present division engineers of the Western Pacific were in the party. The railway company abandoned the work, apparently because of lack of funds. In 1902 the Stockton & Beckwourth Pass Railroad, organized by San Francisco interests, employed Mr. Keddie as Chief Engineer; in 1903 he was succeeded by and associated with George L. Dillman, of San Francisco, and the railway company was consolidated with the San Francisco Terminal Company, under the name of the Western Pacific Railway. Mr. Dillman made a general location through to Salt Lake City and adopted a line north of the present route where the cost of construction was much less, but the maximum grade for a short distance was 2½ per cent. In 1905 Mr. Gould became interested and V. G. Bogue succeeded Mr. Dillman as Chief Engineer. The several branches of the Feather river were carefully investigated, and it was found that by following the main branch from Oroville to the junction of the Middle and North Forks, then the North Fork, East Branch, Spanish creek and Spring Garden creek and tunneling through the divide back to the Middle Fork it was possible to get a one per cent. maximum grade through the Sierras. Ingenious development was necessary, as previously noted, and also at Beckwourth and Flower Lake Tunnels, Sand Pass and other points. From Niles east through the Coast range the line is close to the old line of the Central Pacific, but higher, with more expensive construction, slightly better maximum grade and overhead crossings.

In the Humboldt river valley from Winnemucca to Wells, there is remarkable evidence of the value of careful study in location and of being last in the field in railway construction. The Central Pacific, which was reconstructed in 1904, is 193 miles long with five tunnels of a total length of 8,900 feet and 27 crossings of the Humboldt river. The Western Pacific, 185 miles, has a similar grade, except for one summit more, with rise and fall of 33 feet and an overhead crossing with a loss of 24.5 feet; the track is not undulatory, the curvature is slightly less; there are 5 tunnels, whose total length is 5,300 feet, and 24 pile bridge crossings of the Humboldt river. The line was originally 3 miles shorter than at present, but this distance was introduced to get well away from water. The study given to the location and number of lines run is



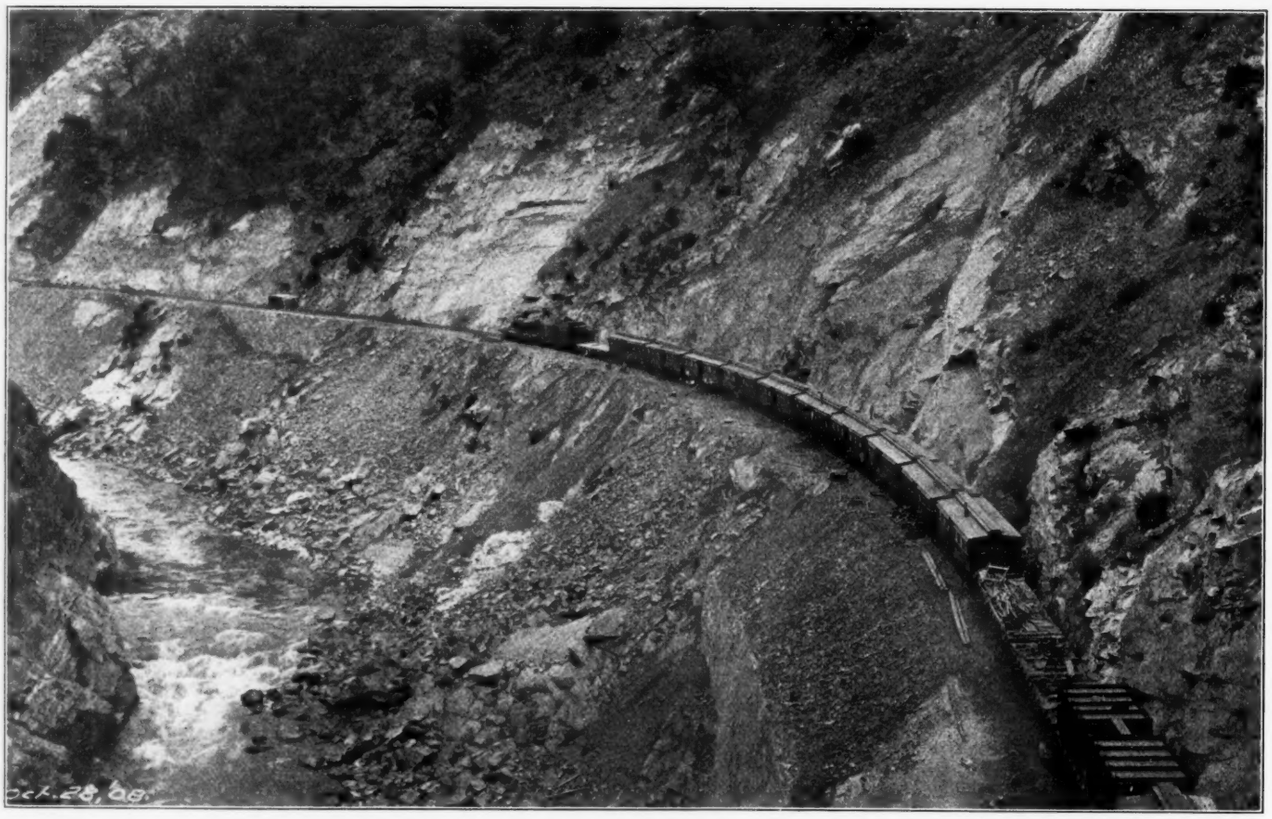
Interior of Unlined Tunnel.

evidenced by the fact that in calculating the length 72 equations in stationing have to be taken into consideration.

GRADES.

The condensed profile of the line was shown in the *Railroad Gazette* of April 12, 1907, and remains practically the same. The maximum grade is 53 feet to the mile. Eastbound, this occurs on 100 miles in the Sierras and two short stretches less than 8 miles each at Flower Lake Tunnel and Silver Zone Pass. Westbound, the maximum grade runs 30 miles getting up Silver Zone Pass, about 10 miles at Antelope Summit and

Berry Creek Trestle and Tunnel.



Looking East from Tunnel No. 6.

for 12 miles from the San Joaquin valley to Altamont. There are two important, three minor and four small summits eastbound, with a total ascent of 9,385 feet, and two important, three minor and three small summits westbound, with a total ascent of 5,076 feet.

ALINEMENT.

The maximum degree of curvature adopted is 10 degrees, compensated at the rate of .035 ft. per degree. All curves of 2 degrees and over are spiraled. Length of tangent between curves is not less than 200 feet. The total number of curves is 932; total length, 957,901.72 feet; total curvature, 30,275 degrees, 65¾ minutes. The average length of curve is 1,027.79 feet and average degree of curvature 3.09. The longest tangent is 42.63 miles. There are forty 10-degree curves; one hundred and thirty-seven 8 to 10 degrees, inclusive, and three hundred and fifty-six 5 to 10 degrees, inclusive. Of the maximum degree curves, thirty-eight occur in the Sierra mountains.

DIVISIONS.

The division points and the length of run between them are as follows:

Division Point.	Mile post.	Length of run, miles.
Oakland, Cal.	3.5	...
Stockton, Cal	93.7	90
Oroville, Cal.	204.9	111
Reposa, Cal.	321.6	117
Deep Hole, Nev.	430.0	108
Winnemucca, Nev.	532.0	102
Elko, Nev.	665.0	133
Wendover, Nev.	807.0	142
Salt Lake City, Utah.	927.0	120

Shops will be located at Sacramento and Salt Lake City.

The following table shows the number of summits, percentage and length of grades on the several divisions:

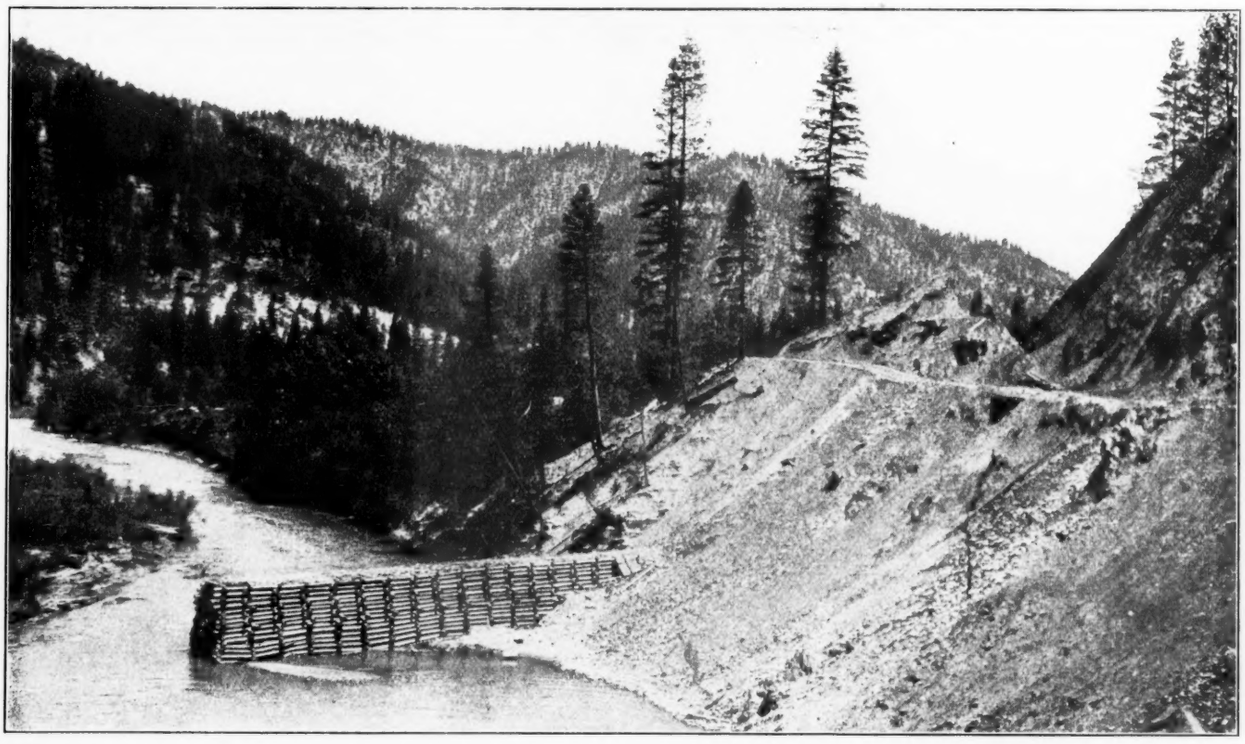
	Eastbound				Westbound			
		P. c. of grades				P. c. of grades		
	Summits.	1.0	0.8,	0.4, or less	Summits.	1.0	0.8,	0.4, or less
		miles				miles		
San Francisco to Stockton	2	8	30	55	2	19	0	72
Stockton to Oroville	0	0	0	111	0	0	0	111
Oroville to Reposa	1	100	0	17	0	0	0	117
Reposa to Deep Hole	2	1	0	107	2	4	18	85
Deep Hole to Winnemucca	1	0	13	89	1	7	0	95
Winnemucca to Elko	0	0	0	133	0	0	0	133
Elko to Wendover	2	15	0	125	2	41	0	101
Wendover to Salt Lake C.	1	0	8	112	1	0	9	111

SPECIFICATIONS.

The important features of the specifications, characteristic of the high class of construction, are as follows:

Grading.—Embankments are made of choice of material with large rock in the base of fills, coarser material on the sides and slopes and selected material on the top. Embankments without borrow pits are protected by bermes and ditches. Embankments on slopes are founded on steps cut into the slope and the toe of embankment is protected by large pieces of rock. Borrow pits are drained to leave no stagment pools. Riprap, slope walls or cribs are used to protect embankments subject to wash of water. In cuts, rock excavation is carried 12 in. below subgrade. Bermes of 20 ft. are required and side drains of large capacity.

Bridges.—Steel bridge structures are used for all important crossings. Forty are required on the road, their total length being 9,261 ft. The designs provide for a loading of two locomotives coupled, each weighing 177½ tons, followed by a uniform train load of 5,000 lbs. per lineal foot. Bridge piers are generally of concrete.



Wing Dam to Protect Embankment.

Tunnels.—The minimum width, inside, is 16 ft. and the larger tunnels are 17 ft. wide. They are 22½ ft. high above the surface of the subgrade, and are also cut 1 ft. below that point. The curve of arch is semi-circular, with springing line 14 ft. above subgrade. Tunnels are generally lined with timber and concrete used where necessary.

Cross Ties.—White cedar, Douglas fir, sugar pine or yellow pine; for the eastern and western ends of the line ties have been brought from Oregon and for the central portion from the section of the Sierra mountains adjacent to the railway. Ties are 8 ft. long, 7 in. thick and not less than 7 in. nor more than 12 in. wide.

Rails and Track Work.—Rails are 85-lb., A. S. C. E. section, furnished by the Colorado Fuel & Iron Co. A large proportion of them are of open hearth steel, intended particularly for use on grades and curves but also used elsewhere. Rails are 33 ft. long, and are laid with broken joints. Ties are spaced not more than 24 in. apart on centers, with selected ties under the rail joint and next to joint tie. Rails on curves

Roadbed of Solid Salt.
Track before being raised and finished.

Great Salt Lake Mud Desert.

are machine curved for all curves over 1 deg. On curves the outer rail is elevated 1 in. for curves of 1 deg. or less and at the rate of ½ in. for each additional degree of curvature up to 4 deg.; on curves of more than 4 deg. an additional spike is required on each tie at each rail and brace chairs are used as directed.

Ballast.—The entire line is ballasted with the most suitable material available and in many cases, where there is a choice of material, it is hauled up to about 50 miles. The minimum depth of ballast is 6 in. below the ties with an increase of depth depending on the character of material in subgrade and the kind of ballast available.

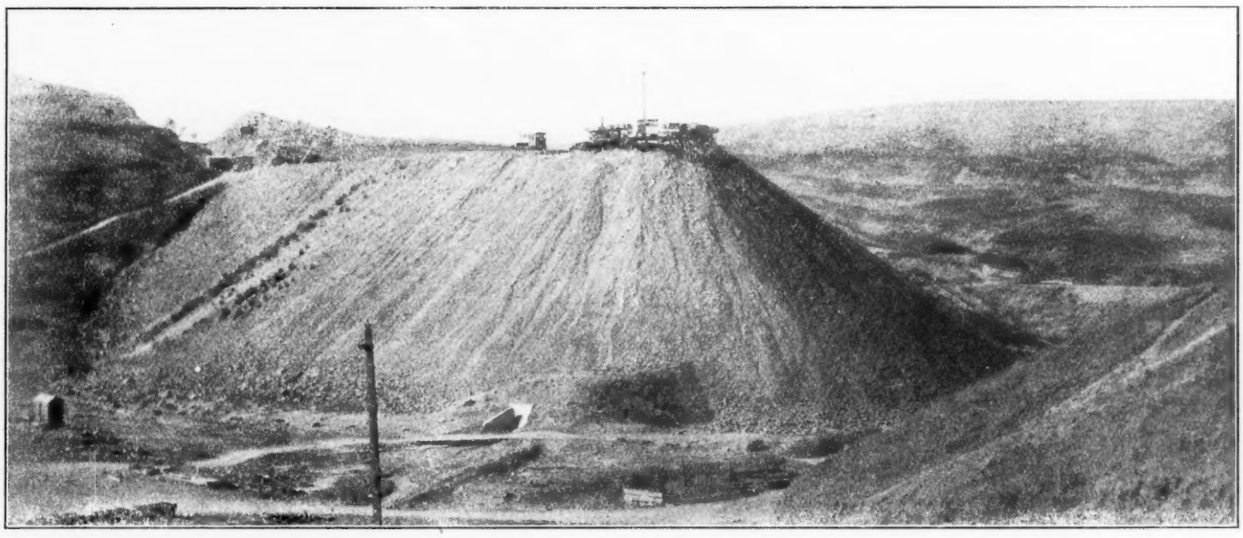
Sidings.—Lengths vary from 2,500 to 4,000 feet. They are laid with second-quality 85-lb. rails or carefully inspected second-hand 65-lb. rails from the Denver & Rio Grande.

WATER.

Whatever may be the facts as to the antagonism between alcohol and mankind in general, it is undoubtedly true that the engineers worst enemy is water. In the construction of the Western Pacific, the engineers have had to contend with water and with the lack of water under conditions some of which are unusual.

'ying material, hastily thrown up at first to permit track to be laid and subsequently raised with coarse gravel and finer material for ballast. Slopes are riprapped where exposed to wave action. During the first winter (1906-7) the material of the hastily made banks was largely carried away by wind and the wash of rains and of shallow water. During the months of June and July, 1907, the water in Great Salt Lake rose nearly 5 ft. above the elevation in January, 1906. The banks were rapidly raised by gravel dumped from trains, and riprap was placed as quickly as possible. Although the water averaged less than 2 ft. in depth, there was constant wash and it was only after increasing the width of banks and coating the slopes with coarse gravel and riprap that wash was reduced to a minimum. This wash was not from heavy wave action in a considerable depth of water, but was from the water blown to the south end of the lake giving slight depth and the apparently insignificant action of waves probably not over 2 in. in height. The sub-grade was about 1 ft. above the lake surface in July, 1907, and is now 3 ft. above, or 2 ft. above maximum elevation.

About 100 miles west of Salt Lake City, the railway reaches the Great Salt Desert and crosses it on a tangent of 43 miles, more than 30 of which are on material of salt and earth



High Fill, Showing Circular Unloader.

Shortly after leaving Salt Lake City, the road follows close to the shore of Great Salt Lake and crosses the southern end of it by a fill in shallow water for about 7 miles. The grade is close to the lake surface and has been largely built with ballast train. The economy of a low bank can be appreciated when it is considered that for miles material could not be scraped by teams from the right of way or adjacent property to a depth of more than a few inches before striking water. The material available in the bottom land is fine sand and silt and is easily blown or washed from the banks; when wet it gives insecure support for a heavy rock fill. The water of Great Salt Lake is heavily saturated with salt and has a surprising effect upon earth or rock fills. The effect of the waves upon a heavy rock fill with earth on top is in evidence in the approaches of the Lucin cut-off of the Central Pacific, where settlement has been caused by undermining the large rock and by wash of both rock and earth. Some smaller stones, lying loose among larger, have been washed about until they have been rounded and largely worn away.

The problem of the Western Pacific was to secure a roadbed, without sacrifice of distance, that would wash or settle least and be sufficiently above water. This has been accomplished by broad, low banks which do not overload the under-

which after rain becomes a mud comparable to the gumbo of Nebraska. Wild animals, cattle and at least one band of emigrants attempting the crossing have perished from fatigue and lack of water, having been unable to proceed or turn back. The problem was to construct without delay and to avoid settlement. Careful soundings has been made and an assured firm bottom found at a depth not exceeding 14 ft. below proposed grade. All material for banks had to be brought by train from the eastern edge of the desert. Planks were laid lengthwise of the track; on these, men stood and the ties were placed, then the rails. Loaded gravel cars were backed out on the track and dumped and the track raised. The completed banks are broad and low; the material coarse, with excellent finer gravel for ballast. No serious settlement has occurred and none is likely.

Toward the western edge, the great salt springs, which contribute largely to the characteristic salinity of the lake, serve the useful purpose of furnishing an excess of salt, making a hard subgrade. For eight miles the roadbed is on a bed of solid salt.

The lack of fresh water for locomotives was another problem. It is brought to the railway by a 6-in. pipe line 18 miles long from a mountain spring 800 ft. above and six miles south,

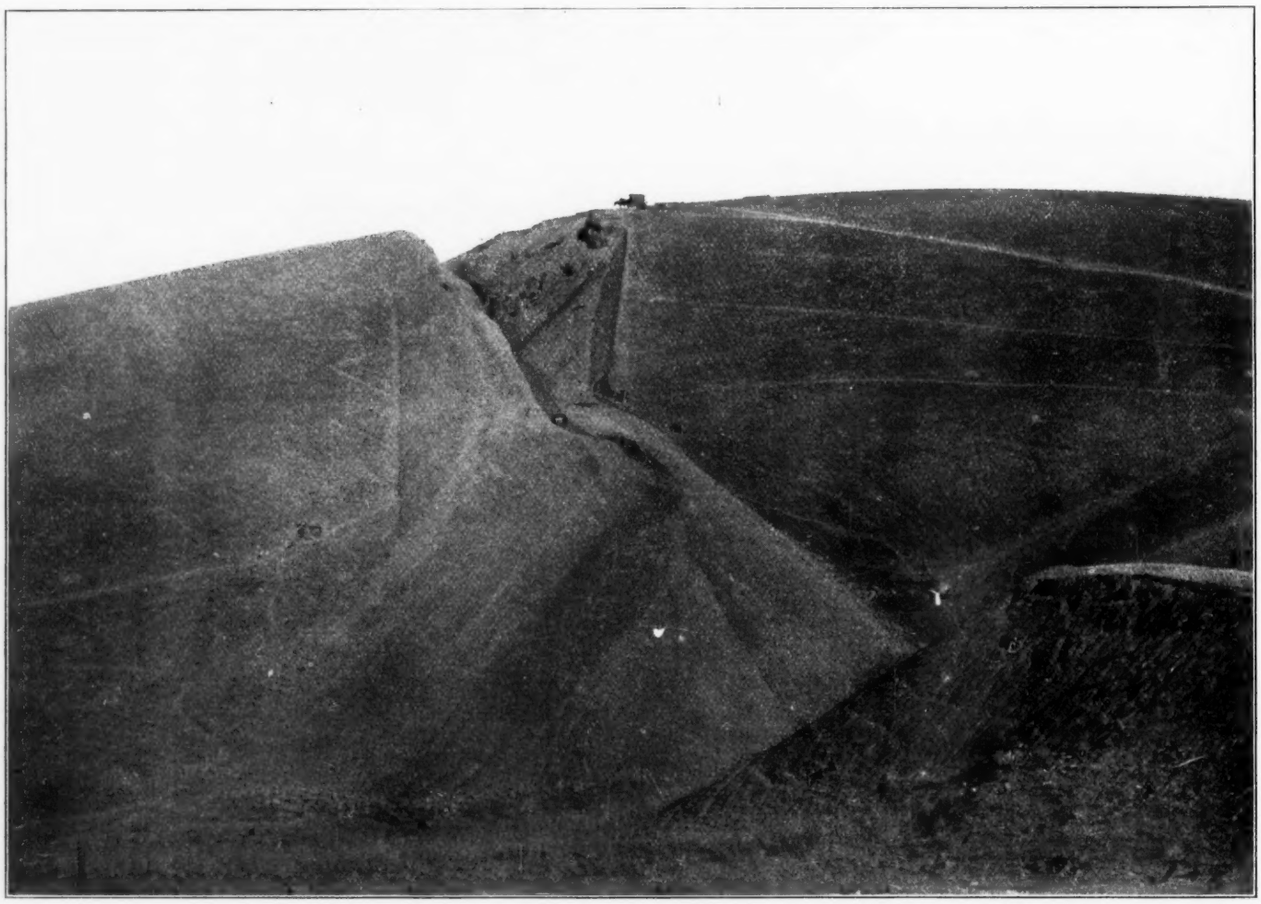
opposite Delle. Later it will be piped to the edge of the desert, about 25 miles further west. From the desert west the water supply is from driven wells or mountain springs; it is excellent but has been secured only after elaborate and expensive search.

In the valley of the Humboldt river, which the road reaches at Wells and follows to Winnemucca, there are 24 crossings. The choice of structure lay between pile trestles, economical, quick to construct but temporary, and steel structures, expensive, a source of delay but permanent. The former were chosen and the slight fall of the river, width of river bottom lands and corresponding sluggish current and minimum danger from ice and washouts make this choice a wise one. The roadbed itself is well above high water.

From Winnemucca to Beckwourth Pass, the summit and eastern edge of the Sierras, there are no problems from water except to secure an ample supply of fresh water. Just west of Beckwourth Pass the line enters Sierra Valley, the source of the Middle Fork of the Feather river, and except for a change to the North Fork it follows the waters of the Feather river to the Golden Gate.

Through the Sierras the problems of handling or avoiding water are those usual to railway construction in mountain country, except that the streams are more than usually subject to flash rises. The high water of April, 1907, the highest on record at many points, proved the general safety of the location of the line and gave valuable information as to desirable increasing of channel sections by blasting large boulders and projecting points. Crossings of large streams are by substantial steel bridges on concrete piers. Culverts are of hewn timber, as befits a timber country, and large enough to permit the placing of cast iron pipe and concrete parapet walls when the time shall come. Where a high fill occurs over a waterway, the stream, if possible, is diverted and taken on either hill side in an artificial channel with flat slope, to beneath the track close to grade, thereby reducing the velocity of the current and avoiding the danger of damming and washout or scour of a culvert at the bottom of the fill. It also makes less expensive construction. Care is taken to make the bottom of the fill of large rock to allow water from the small adjacent drainage area to seep through. All slopes on the upper side of both cuts and fills are well protected by side ditches of ample capacity. Fills with toes in a stream are rip-rapped or protected with wing dams, and many channel changes have been made of streams to get the water away from too close quarters.

One of the most valuable features of the railway lies in its relation to snow. The moisture-laden winds of the Pacific pass over the Sierras and give heavy snowfall, but east of them it is not considerable. In the valleys of the Sierras the depth of snow varies according to elevation and locality, the latter undoubtedly due to the effect of adjacent mountain peaks on the moisture-laden winds. The Western Pacific has its summit at Beckwourth Pass at the extraordinarily low elevation of 5,018 ft. and thereafter runs in a zone exceptionally free from snow. Not only are these natural conditions extremely favorable, but the line has been, generally, located on the northern or sunny side of the slopes of the valleys. As a result, the depth of snow on that portion of the line in the Sierras will rarely exceed 2 ft. for about 50 miles and will be taken care of by a single snow plow, which for frequent winters will not be used at all. There are no snow sheds, and maintenance charges due to snow will be a minimum. At the summit of the Central



Electric Scraper at Work in Cut and Fill.

Pacific the average maximum depth of snow exceeds 20 ft., and 40 miles of snow sheds are required.

Following the turbulent waters of the Feather river, the line reaches the edge of the Sacramento valley at Oroville, and to a point beyond Stockton runs almost due south in a flood country crossing the tributaries to the Sacramento from the east by long bridge structures. A grade line well above the surrounding country and frequent openings, in size based liberally upon experience, are the features. Slopes adjacent to openings are rip-rapped. Cement pipes with concrete parapet walls are used for small openings; pile trestles or beams on small concrete piers for those of moderate size, and steel spans for the more important crossings. It is a practice established by the Southern Pacific to construct the piers of larger bridges of piles heavily planked. The Western Pacific avoids the tule swamps, which are crossed by both the Southern Pacific and Santa Fe and have been a source of much difficulty in maintenance because of settlement and creeping track.

Marysville, Sacramento and Stockton are in the low lands of the Sacramento valley and in flood season are protected by levees. Stockton offers no serious difficulty for a railway entrance, but Marysville apparently necessitated either heavy grading, overhead street crossings and yards outside the city or station grounds, with a grade each way and complications regarding street crossings. The difficulty was avoided by using the west levee and grading yards adjacent to the center of the city by borrowing dredged material from the Yuba river. At Sacramento the Central Pacific main line occupies the levee on the north, and a grade crossing and elevated tracks across the city were undesirable. On the south the ground is higher, the levee is crossed at grade and the line rises from the level of the city streets. At the Central Pacific tracks the Western Pacific has built an undercrossing from which, to the north, the line rises to a second levee on the banks of the American river and the bridge crossing. The levee at this point was raised and side levees carried south to the main levee. As an additional precaution against flooding the city, heavy gates, designed to keep out the water, are built as a part of the undercrossing. In January, 1909, these saved the city from flood.

In San Francisco bay the waters are infested with the teredo. All dock and bulkhead work is of timber impregnated with 12 pounds of creosote oil to the cubic foot. The Oakland shore has a gradual slope and has necessitated constructing terminal grounds, comprising 359 acres, for a distance of two miles from the shore line. Material has been pumped by dredges and retained by an existing government wall on the south and by bulkheads.

CONTRACTORS' METHODS.

The Utah Construction Co., Ogden, Utah, have several contracts for grading, covering that portion of line from Salt Lake City to Oroville, Cal., about 725 miles. Its methods of handling the work have been on old-fashioned lines, but with well equipped camps, ample supplies and a large mechanical outfit. Its stock has been sturdy, well taken care of and well fed. Exceptionally good management has been shown in keeping camps well supplied with good food and water, and this has been no small undertaking for work on the desert and in the canyons. In the canyon of the Feather river a wagon road for hauling supplies was constructed in advance of railway construction and at an expenditure of nearly $500,000.

In the spring of 1907, Oroville was flooded and cut off from railway connection for 10 days. This construction company opened its storehouse for the supply of the citizens, somewhat to its own inconvenience and loss. On the work it has had steam shovels and a large supply of simpler mechanical equipment, but has not gone into any elaborate new methods of doing work. One of its sub-contractors undertook to make a large cut and fill by hydraulic methods. He was successful in so doing, until the work was stopped by the Government Debris Commission because of some real or fancied waste of material to the river. The debris laws forbid hydraulic mining or deposit of material in any tributary of San Francisco bay.

The E. B. & A. L. Stone Co., San Francisco, had the contract for grading between Oakland and Oroville and made use of several ingenious methods of handling earth. A scraper, hauled by cable and electric power, was installed in one of the large cuts near Altamont but did not prove entirely successful because of frequent breakdowns and was finally abandoned. On another large fill a device known as the merry-go-round was installed at the end of the fill. It consisted of a revolving table with tracks upon which dump cars were backed and from which material was distributed over a wide area and in advance of the solid bank, thereby avoiding the use of trestle.

The Western States Construction Co. has the contract for a tunnel in San Francisco and constructing embankment between the east end of the tunnel and the freight slip at the water front over soft ground. The length of fill between streets was 250 ft. with grade 35 ft. above the mud flat. It was necessary to first fill with rock, and in some places this sank to a depth exceeding 30 ft. in the mud. The use of a temporary trestle was not feasible and suspension cables 2 in. in diameter were strung over the length of the fill to support a temporary track from which material could be dumped to make the fill. The temporary track, about 50 ft. in length, with supporting timbers, was hung from the cables and rested on the finished dump at the inner end. It was moved forward as the material was placed, thereby avoiding the use of trestle.

Track laying was done by the railway forces, and track-laying machines were used when any considerable length could be laid continuously. Over a mile of track per day was frequently laid; the best record was 7,800 ft., between Sacramento and San Francisco.

On March 1, 1909, 60 per cent. of track had been laid; 90 per cent. of grading done; 28 out of 42 tunnels completed, and all others nearly completed; and 24 out of 40 bridges erected. The portion of the line from Salt Lake City to Shafter, 160 miles, is in operation with trains three times a week, and from Marysville, Cal., to Berry Creek, 46 miles, with daily service. It is expected that the entire line will be in operation by the fall.

INCREASED EXPENSES ALL OVER EUROPE.

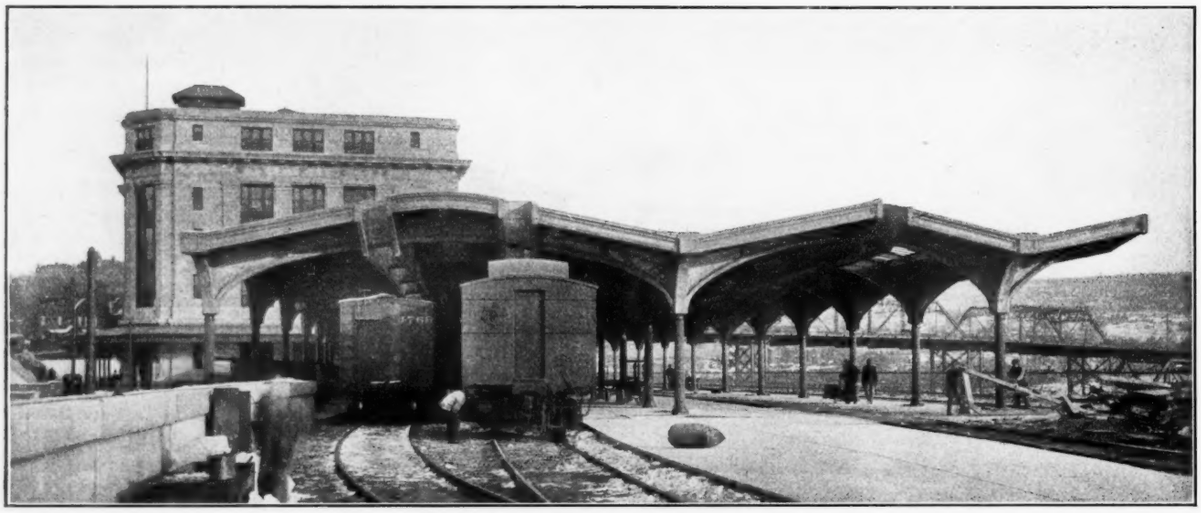
The *Journal* of the German Railroad Union, reviewing the year 1908, remarks that all over Europe railway earnings have tended to decrease, while working expenses increased. Up to that year the increase in working expenses was due chiefly to higher prices for supplies, especially coal and iron. In 1908 higher wages was the chief cause. The rapid increase in traffic for some years previous had compelled important increases in the number of employees, and the general prosperity an increase in wages. A very large part of these employees form a permanent corps, not discharged whatever the condition of traffic, and with rates of pay intended to be permanent. Under these circumstances the percentage of earnings absorbed by working expenses has been larger than ever before, approximating the proportions with which we have long been familiar in America.

The Austrian state railway authorities have drawn up a scheme for higher rates, expected to add about $1,000,000 annually to passenger and $7,000,000 to freight earnings. The state has recently acquired important private railways whose rates were higher than the state railway rates, and the application of the proposed new rates will leave them somewhat lower than the old company rates, but will advance charges on the old State stystem.

BUSH TRAIN SHED AT SCRANTON.

The accompanying photographs show the train shed at the new Scranton, Pa., station of the Delaware, Lackawanna & Western. A general description of this station appeared in the *Railroad Age Gazette* of November 13, 1908. This is the second shed of this kind erected under the designs of Lincoln Bush, until recently Chief Engineer of the Lackawanna, and now a consulting engineer, with office at 1 Madison avenue, New York. The first one, that at the Hoboken, N. J., terminal of the road, was described in *The Railway Age* of August 25, 1905; the *Railroad Gazette* of September 1, 1905; and *The Railway Age* of May 29, 1908.

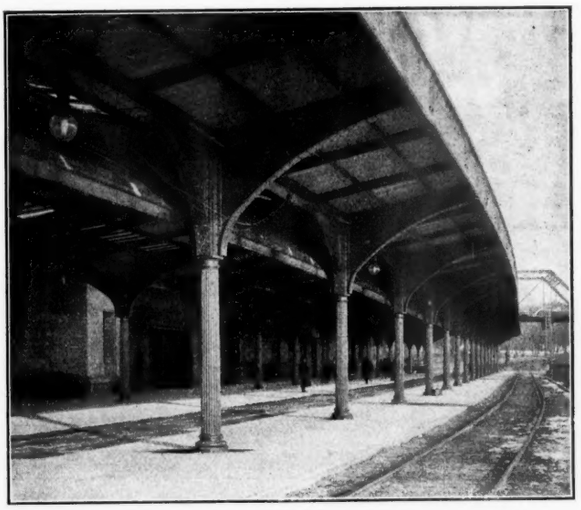
The Bush train shed consists of longitudinal units meeting over the tracks so as to make a continuous structure, except for the narrow openings, or smoke ducts, over the locomotive stacks. The roof is supported on longitudinal rows of columns, 27 ft. apart on centers, resting in the reinforced concrete platforms. The transverse main rafters are continuous between the columns and form the only breaks in the con-



End View of Bush Train Shed, Scranton.

Bush Train Shed at Scranton.

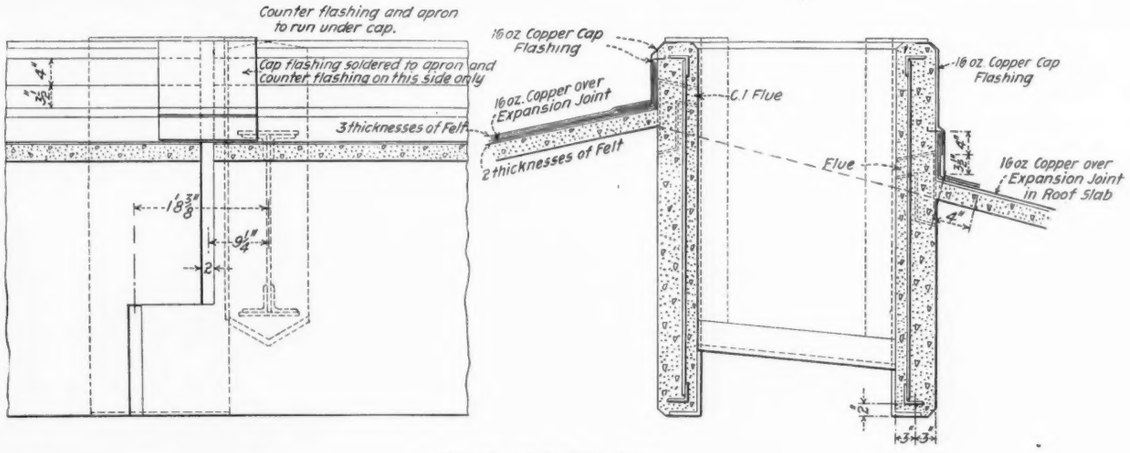
tinuity of the openings over the smokestacks. The vertical clearance from the top of the rail to the underside of these main rafters at center line of track is 16 ft. 6 in. Framed to these rafters are longitudinal purlins which support the reinforced concrete roof slabs and the skylights. Between the columns are longitudinal girders supporting the inner ends of the intermediate rafters, whose outer ends are riveted to the framework of the smoke duct purlins. This framework consists of a pair of light, latticed purlins.



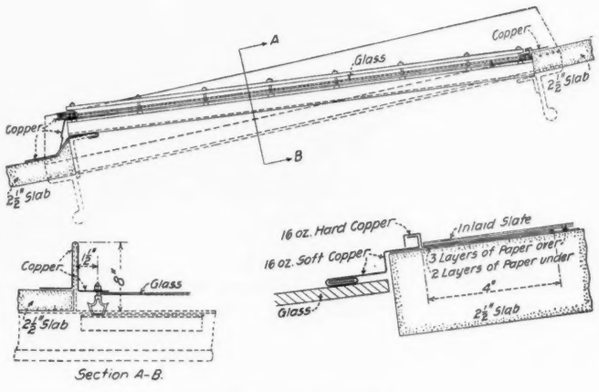
Side View of Bush Train Shed, Scranton.

The longitudinal girder between the columns is built up of two channels and a plate, forming a trough, which is lined and sloped with concrete with a surface finish of copper and serves as a rain-water gutter. The girder is braced at the columns with gusset plate and angles, built up with a curved flange corresponding to that of the main rafters, so that the four members spring away from each column on harmonious lines. The columns are of cast iron and the roof framework of wrought steel. The weight of the metal complete per square foot of shed area, including columns and anchor bolts, is 20.09 lbs. The roof slabs are of concrete, 2½ in. thick, reinforced with 3-in. No. 10 expanded metal, the finished surface being four-ply slag.

The steel framework of the smoke ducts and the main rafters where they pass through the smoke ducts are encased in concrete. This concrete casing is reinforced with expanded metal. At the ends of the shed, and at cornices along the two sides of the shed, all metal work is encased in concrete, as shown in the photographs. The sides of the ducts are high enough to prevent driving rain or snow from reaching the platforms. The longitudinal gutters mentioned above are drained by leader pipes running down inside every other supporting column, where they connect with drains under the platforms. The air space between the inside of the columns and the outside of the drain pipes insulates them from freezing, and the drain pipes are not exposed, adding to the appearance of the shed and eliminating possible damage to drain pipes from baggage trucks. The electric lights are arranged in longitudinal lines between the columns. The arc lights visible in the accompanying photographs were installed for temporary use only. In day time, ample light reaches the interior through the skylights and the smoke ducts. In the


Counter flashing and apron to run under cap.
Cap flashing soldered to apron and counter flashing on this side only
3 thicknesses of Felt
16 oz. Copper Cap Flashing
16 oz. Copper over Expansion Joint
2 thicknesses of Felt
C.I. Flue
Flue
16 oz. Copper Cap Flashing
16 oz Copper over Expansion Joint in Roof Slab

Details of Smoke Duct.



Details of Skylight.

Hoboken shed, the combined area of skylights and smoke ducts is about half the total area of the shed.

The main advantages of these sheds are: first, the original cost is much less, being about 40 per cent. less than the cost of a high-roofed shed in the case of a large terminal; second, cost of maintenance is very much less; third, there is more light; and, fourth, there is no smoke or gas inside the shed and much less noise. One of the large items of saving is in maintenance cost of painting. The steel work is never exposed to engine gases and smoke. At the smoke ducts, where it would be in contact with these gases, it is protected by concrete. The accompanying drawing shows the details of the smoke duct construction. In the walls of the duct immediately under roof slab are small flues which allow any gases which might get behind the smoke duct, or any heated air rising from the platform level, to escape to the duct and thence to the open air. When paint is required, high scaffolding is not needed, which means a further saving. Aside from

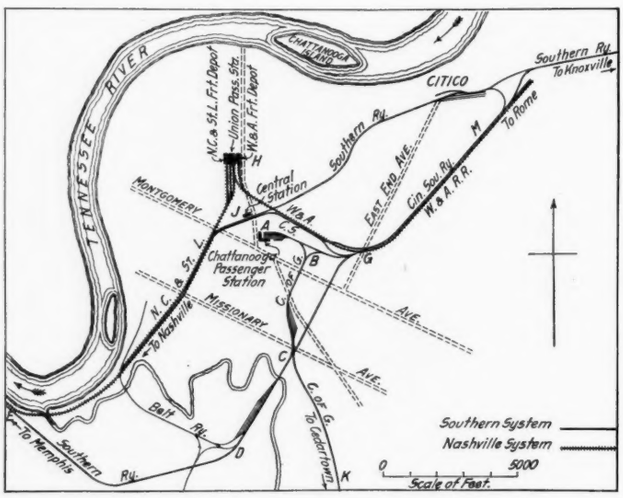
material, there is saving in the first cost of the shed because of the ease of erection. Everything can be handled by derrick cars, doing away with false work, and the work is easily carried on without interference with traffic or inconvenience to the public.

As the accompanying photographs show, there are skylights on each side of the smoke ducts, admitting light directly to the windows of the cars on the track below. They are Anti-Pluvius skylights, made by the G. Drouve Co., Bridgeport, Conn. They are laid in units. The frame of the skylight is a ⅛-in. channel on which, at intervals of 18 to 20 in., are fastened malleable iron bridges or stirrups. These support flat iron bars with elongated holes engaging brass studs screwed into the stirrups. The glass plates rest on sheet metal guides, strips of cow hair felt being laid between the glass and the guides as cushions, while on top of the glass are corresponding strips of felt, held in place by sheet metal guides. No putty or cement is used. An accompanying drawing shows the details of the skylight construction and the copper flashing which protects the joints. Three-eighth inch glass is used, made by the Mississippi Wire Glass Co., New York. In the Hoboken shed, sheets of glass 27 in. x 86 in. were used. These proved to be rather too large, a number of them cracking, although this is not as serious as would be the case if plain glass were used, as the wire reinforcement holds the glass together and there is no leakage. In the Scranton shed, the sizes were cut down to 20 in. x 60 in., which is now believed to be the best size for skylight work. This size will also be used in the skylights which are going to be installed in the Bush train shed of the new Chicago & North Western passenger terminal at Chicago. In other respects, the skylights in the Scranton shed are nearly the same as those in the Hoboken shed, except that their area is not so large in proportion to the total roof area, the shed being narrower and entirely open on one side. In the Hoboken shed, side lights of similar material are used. The roof of the Bush shed is accessible for painting, cleaning or removal of snow. In the Hoboken shed, however, this has not been necessary, dirt and smoke not accumulating on the glass. In the winter of 1906-1907, although there were four heavy snowstorms, no snow was shoveled from the roof or skylights. Light penetrates a moderately thick layer of snow lying on the skylights. In one case, with 10½ in. of snow on the shed good and ample light came through the smoke ducts. Although there were high winds during this storm, not more than ⅜ in. of snow reached any of the platforms. If snow is removed from the roof, it may conveniently be shoveled through the smoke ducts into gondola cars beneath.

CHATTANOOGA PASSENGER TERMINAL STATION.

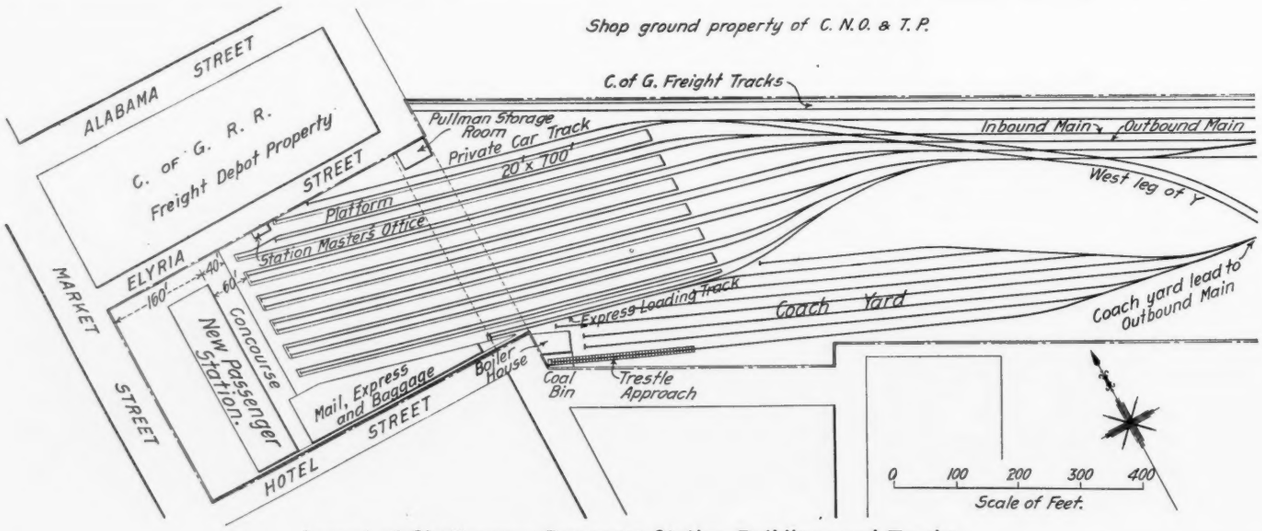
The new terminal station of the Chattanooga Station Company will care for the passenger trains and traffic at Chattanooga, Tenn., of the Southern Railway, the Central of Georgia, the Cincinnati, New Orleans & Texas Pacific, and the Alabama Great Southern.

The station building is essentially a useful, straightforward and clean-cut structure, easy and economical of maintenance, with no waste spaces. There is no attempt at extravagance or overloading of any kind, either in ornamentation or color. The exterior is harmonious and interesting in color and design, big and simple in scale, original in treatment and has a strong individuality and character.



Location of Chattanooga Passenger Station.

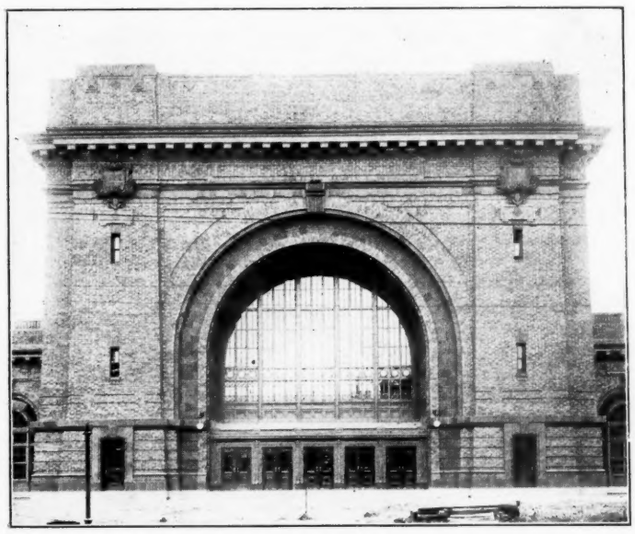
In planning the terminal, it was designed primarily to suit the uses of the average individual, giving him every possible convenience and comfort that he has a right to expect, and then to make the building sufficient for the uses of a great number of people by simply increasing each service to the capacity required. The majority of people using a railway station are strangers. A stranger departing from a town goes to the station and on arriving at the building the first thing that occurs to him is how to get into the building, and then how much time he has to catch his train. Therefore the most important and unmistakable features of a station facade



Layout of Chattanooga Passenger Station Buildings and Tracks.

should be a door and a clock. In a large building, where many door and window openings are necessary, the entrance should be so clearly marked that there could be no question whatever, in the mind of a stranger, where the door is through which he must enter.

The accompanying photograph of the facade of the Chattanooga station shows that there could be very little question as to where the main entrance is, it being in the center, projecting beyond the main wall and being the largest opening of the facade. It is, moreover, of such dimensions that the stranger would be instinctively drawn to this entrance. In the center of this large opening, over the doors, is to be a clock, so that once one starts to enter the station he will do so naturally and at the same time be able to see how much time he has before his train leaves.



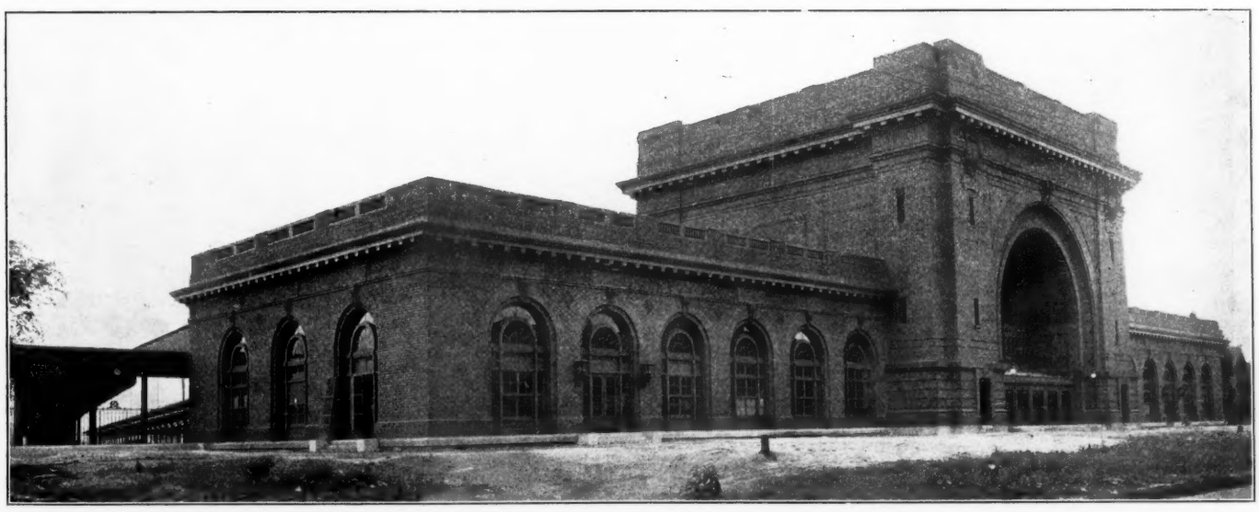
Main Entrance.

When he enters through the outer door he finds himself at once in a large, light, so-called waiting room. In the case of the Chattanooga station this name is badly applied, as the large central dome-covered room is in reality little more than an ample passageway to the trains, around which are disposed, plainly visible, all the services that might be necessary to the man taking a train. This latter point is a most important point in planning a building of this type, as a stranger should not have to be directed by signs and guides to the natural and usual services. On entering the waiting room, he can see at a glance the ticket office, telephone and telegraph offices, the entrance to the lunch room, paper and magazine stand, fruit and cigar stand, smoking room, which is really the waiting room for men, the ladies' retiring room and the information bureau, while straight in front of him he finds the same size doors as the ones he has entered, leading to the concourse and trains. All this service, therefore, becomes quick and easy of access, and he can go to one or more of them directly and without loss of time. The fact that a man has use for a waiting room and smoking room in the station, presupposes a certain amount of time at his disposal. On entering the smoking room, he finds the same sequence of special services, barber shop and other conveniences provided for him. The ladies' waiting room is provided for in a quiet corner of the building, leading out of the main room, but away from the noise of trains and confusion of the station service, and providing a reasonable and comfortable spot in case waiting becomes a necessity.

Refreshment service, both lunch and dining room, are arranged so as to be accessible from the town side, directly from the station itself and from the concourse. This latter access is provided for people who might be coming in on one train and going out on another, and wishing to take a meal at the station between trains. Passengers can go directly to the dining room from the concourse and go back to the train without having to go through the station proper, thereby avoiding the confusion of arriving and departing passengers.

Negroes are provided with the same simple, direct and logical scheme of service; their department has been also so planned that no signs or guides are necessary to direct them where to go for what they want.

In close connection with the general waiting room service, the outgoing baggage room is so arranged that a person can enter the waiting room, buy a ticket and check his baggage and get on the train, his progress being more or less in the same line and direction, thereby saving time and complication. The gates to the trains are numbered, and there only are signs to be found, these being necessary, as several trains, of course, use the same tracks at different times of the day and night.



Chattanooga Passenger Terminal Station.

The incoming passenger wants to get out of the station as quickly, as directly and with as little trouble as possible. Platforms from the incoming trains lead to the main concourse, and from this main concourse the incoming passengers can go directly to the street, to the cab stand and hotel

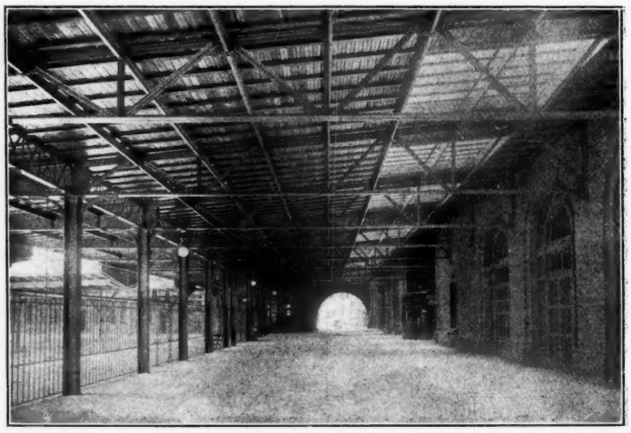
busses without having to go through the station proper. Incoming baggage is taken care of in a room opening off the concourse. The cab stand, etc., is at the end of the concourse.

Quite apart from the passenger service, and still directly accessible to the tracks, as well as to the street, are the United States mail department and the Southern Express building. Also centrally located, in a small separate building, are the station master's quarters and the railway telegraph department. All the buildings are heated and served from a separated and isolated power plant building, which, although the station is fireproof in every way, takes the boiler and machinery equipment, and other possibly dangerous features, out of the building proper, thereby minimizing the fire and accident risk.

The following are some of the general dimensions of the important rooms and services:

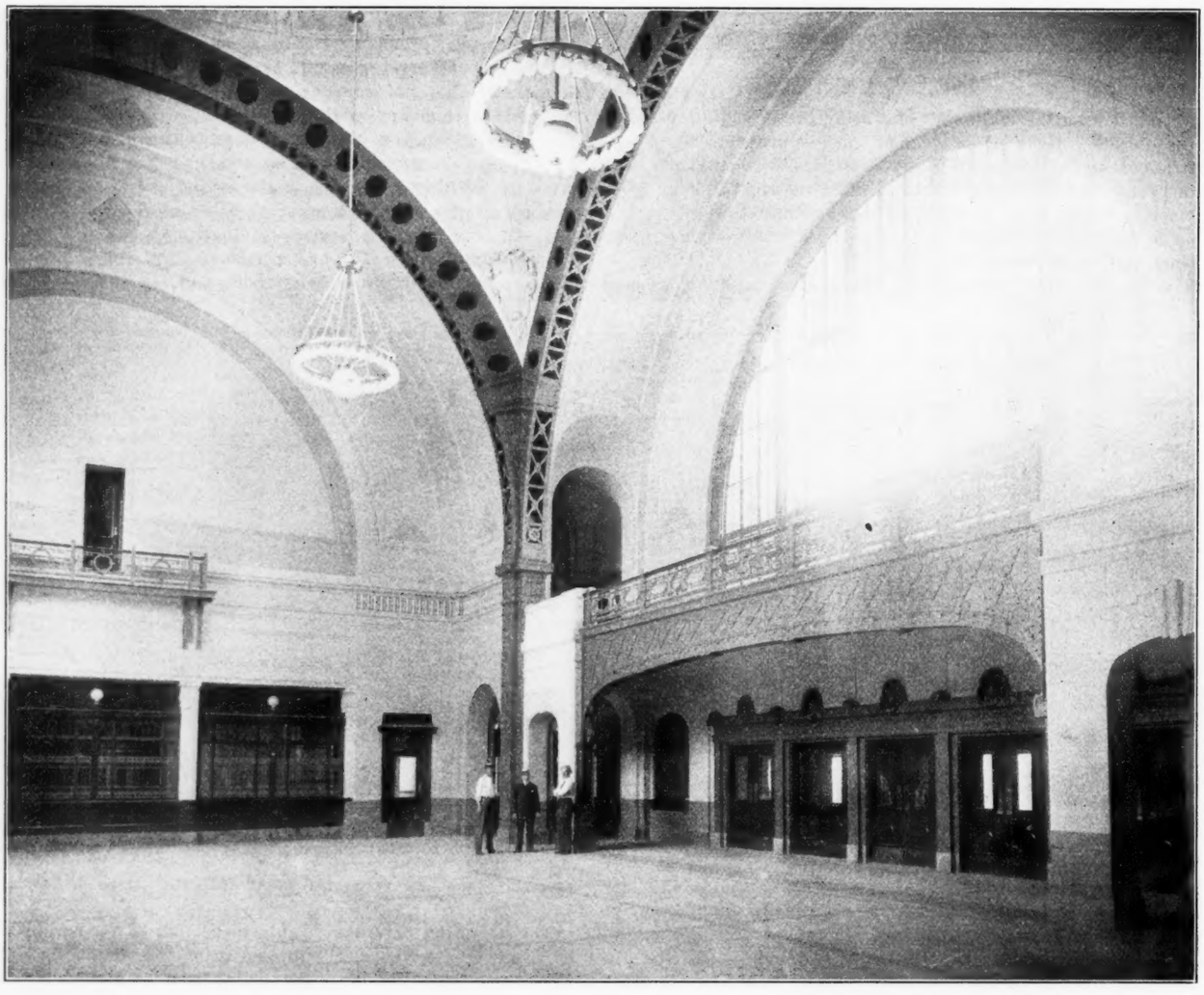
Main waiting room	68 ft.	x	82 ft.
Men's smoking room	34 "	x	42 "
Ladies' retiring room	26 "	x	40 "
Lunch room	24 "	x	72 "
Dining room	38 "	x	42 "
Main concourse	60 "	x	310 "
Ticket office	21 "	x	40 "
Baggage room	60 "	x	80 "
Mail room	48 "	x	75 "

The accompanying map shows the location of the new terminal with respect to the various railways entering the city. The new passenger station is at "A." It is an end station, and the trains of the Southern and the C., N., O. & T. P. from the north and northeast will enter over the lines of the C., N., O. & T. P. at East End avenue (M. G. on the map), while trains from the south and southwest will enter over lines of the Central of Georgia (K. C. B.) and the new lines of the Southern and the Alabama Great Southern (F. E. D.).



Concourse.

No freight trains will enter the new station, this being strictly a passenger station. At the point "C" (crossing of the Central of Georgia by the Belt Railway) freight trains

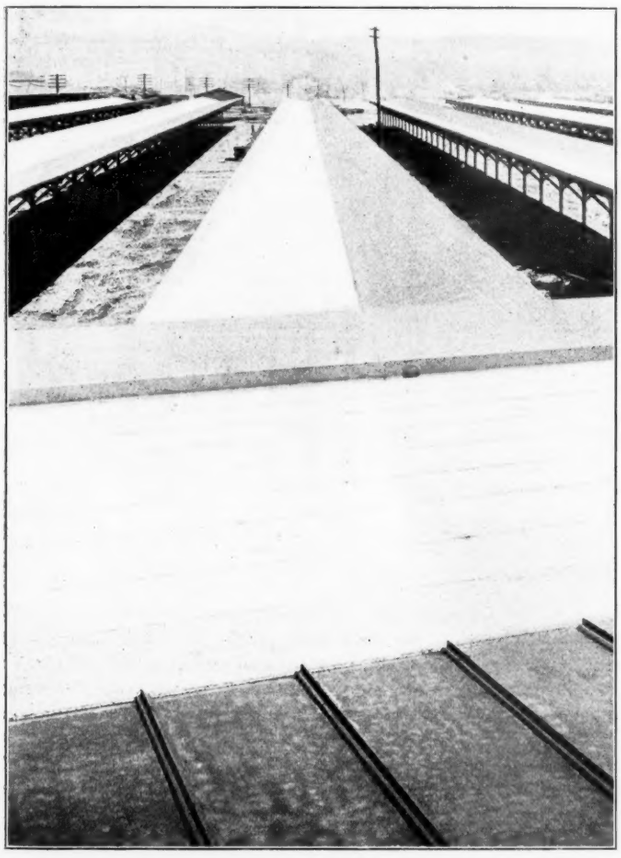


Main Waiting Room; Chattanooga Station.

will continue on the Belt Railway from "C" to "G" and connect with the C., N. O. & T. P. at East End avenue. Passenger trains will take the Central of Georgia from "C" to "B" and enter the passenger station at "A."

To facilitate the movement of trains within the yards of the station company and to enable all trains to back into the station, the double track main leads are arranged in a Y, about 1,800 ft. east of the concourse of the main building. There are 14 tracks entering the station, and there is an eight-track coach yard south of the passenger tracks, with a capacity for storing about 65 coaches.

There are six individual sheds, of the butterfly canopy type, each 700 ft. long, and six concrete and granolithic platforms 20 ft wide. A concrete platform runs from the concourse along the baggage, mail and express departments and terminates at the east end of the passenger sheds. This platform is for handling or trucking baggage and express matter. The west leg of the Y runs through to the north side of the platforms



Skylights, Roofing and Train Sheds.

and forms a ladder track with a series of double and single slip switches from which any track leading into the station may be reached. In each lead to the Y there are two tracks, No. 1 being an inbound track and No. 2 an outbound track.

The whole system of tracks composing the Y, the leads thereto, and the double and single slips are controlled by all electric interlocking from a brick tower two stories high, situated within the Y, from which tower every switch and signal is visible. The frame in the tower contains 105 working levers, with 11 spare spaces. The power is furnished by a 3-h.p. motor generator, and there are 57 storage battery cells. The signals are semaphores on iron posts. The interlocking includes insulated track joints and electric lighting of signals. Wooden trunking is used for conduits.

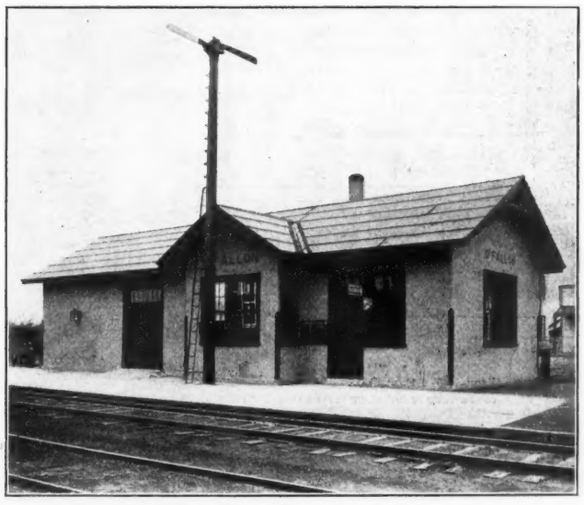
The general layout for the yards and tracks is shown on the accompanying plan. The west leg of the Y is a 10-deg. curve and the east leg about 13 deg. The station tracks are laid with 80-lb. rail, and the Central of Georgia freight tracks with 70-lb. rail. The coach yard is laid with 60-lb. rail and stiff No. 7 frogs. For the station tracks, No. 8 spring-rail frogs are used on turnouts, and the slip switches have movable switch points.

Electric current for the station building is furnished by the city. The power house for heating was built by George Becking, Chattanooga, who was also the contractor for the train sheds. The heating and lighting was laid out by Henry G. Meyer. The Black & Boyd Manufacturing Co., New York, furnished the lighting fixtures, and the J. Livingston, Jr., Co. handled the electric wiring. The plumbing fixtures were from the John Douglas Co., Cincinnati, Ohio. The Eastern Granite Roofing Co., New York, supplied the roofing; it was laid by J. C. McFarland & Co., New York, who also made and put in the sheet metal work and skylights. The hardware came from the Yale & Towne Manufacturing Co., New York, and the interior finish from the Batavia & New York Woodworking Co. The General Railway Signal Co., Rochester, N. Y., furnished the signals.

We are indebted for the above description to Fairfax Harrison, President of the Chattanooga Station Co., to Donn Barber, Architect, and to William D. Jenkins, Engineer in Charge.

SMALL FIREPROOF PASSENGER STATIONS ON THE WABASH.

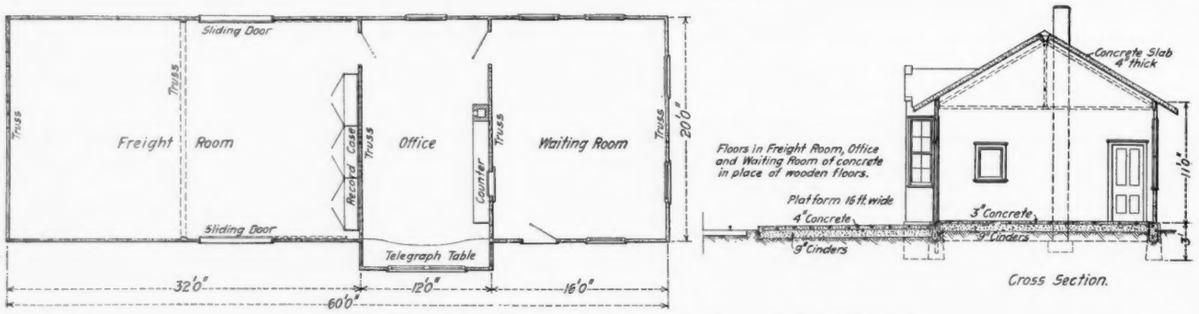
The Wabash Railroad has been building at various points on its line small stations of fireproof construction to take the place of wooden buildings. The first was built at Manhattan, Ill., not far from Chicago. The framework is steel with



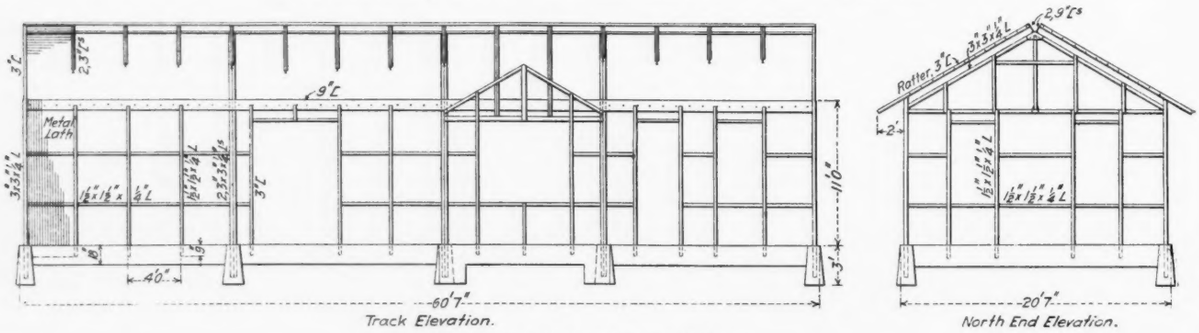
Fireproof Station for the Wabash at O'Fallon, Mo.

"Trussit" lath attached thereto, on which is plastered a wall 3 in. thick. The roof is made in similar manner, without using forms, but is 4 in. thick. This station is as nearly fireproof as it can be made, and for this reason the ceiling follows the contour of the roof. The floor is concrete. Alternate floor plans were put on the drawings, one being wood laid on cinders; but concrete was used in this building as well as in another of the same style at Sullivan, Ill. The cost of these stations, with the platforms, was around $2,000 apiece.

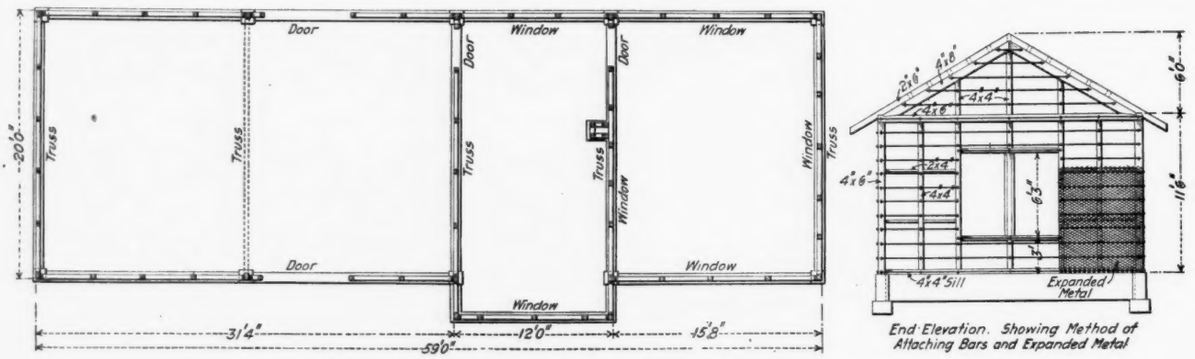
This cost was thought too great for small-town stations such as these and it was therefore decided to try another design having a wooden framework. Drawings of this are shown also. Three of this design have been built, at O'Fallon and Jameson, Mo., and Milan, Mich. Expanded metal is attached to ½-in. round iron bars secured to the studs of the building



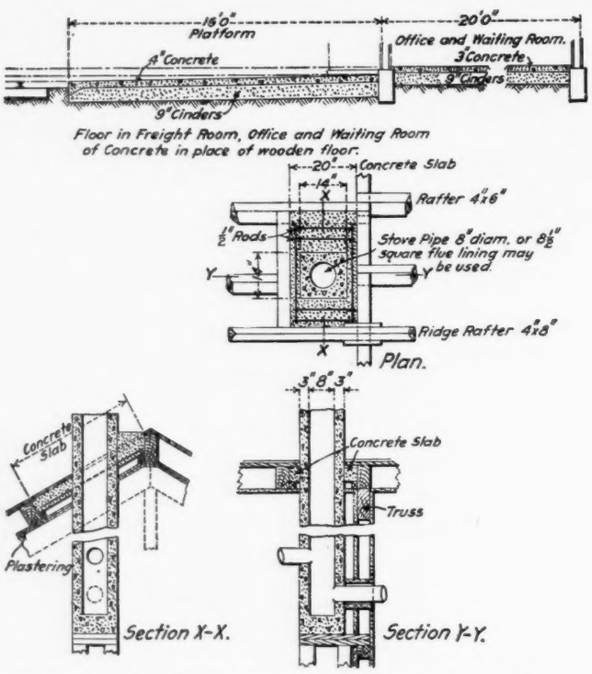
Plan and Cross Section; Manhattan Station of the Wabash.



Framing of Manhattan Station.



Wabash Fireproof Station with Wooden Framework.



Flooring and Details of Chimney in Wooden Frame Station.

both inside and out and plastered, the outer wall being 1½ in. thick, plastered on both sides of the expanded metal, and the inner wall 1 in. thick, plastered on one side. The ceiling is attached to the under side of the roof purlins, thus leaving no vacant space between ceiling and roof. This construction is practically fireproof.

Special attention was given to the chimney. It is made of concrete, with either a stove pipe lining or a tile flue. Where the chimney passes through the roof there is a concrete slab. A common cause of fire—faulty chimney construction and inadequate protection at ceiling and roof—is avoided by these precautions. These stations also have the concrete floors overlaying cinders, instead of wood. These stations cost about $1,500 each, or about the same as a frame station of the same size. They present a pleasing appearance, both inside and out, are substantial, and the maintenance charges should be low.

We are indebted to A. O. Cunningham, Chief Engineer, for the foregoing data.

A number of the Chinese railways, by their charters, are privileged to import railway materials free of duty. The other companies have, for the most part, obtained a similar privilege by administrative decree. It has now been decided that these latter may enjoy this privilege only for three years. The others have it permanently by contract. This will affect chiefly lines not yet built.

ANNUAL MAINTENANCE OF WAY CONVENTION.

The first session of the tenth annual convention of the American Railway Engineering and Maintenance of Way Association was called to order at 10 o'clock a. m. on Tuesday, March 16, at Chicago, by the president, William McNab, Principal Assistant Engineer of the Grand Trunk Railway.

The minutes of the last meeting were adopted without reading and the president then delivered his annual address.

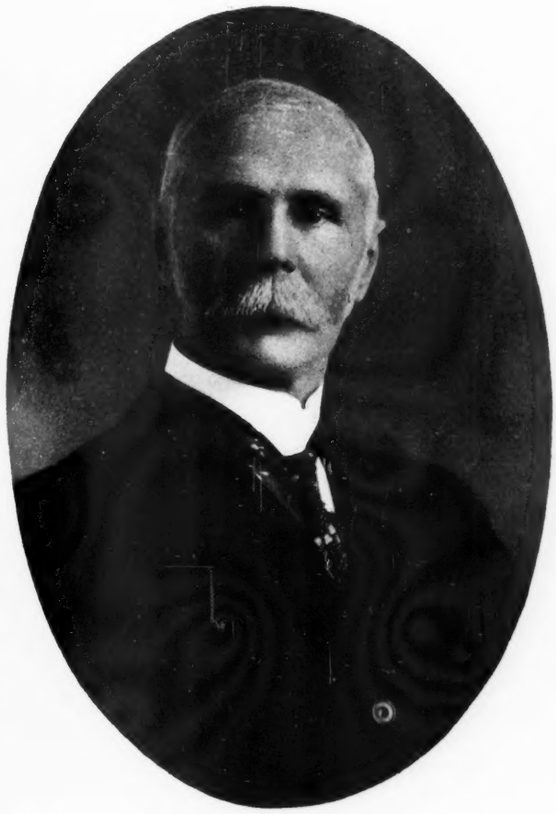
President's Address.

Your association has completed a decade of active work, and during that period has made an enviable record, and now occupies a prominent position in the front rank of railway organizations and engineering societies.

The advantage gained by this status turns on the beneficial influence it exerts in connection with the objects of the association — the advancement of knowledge pertaining to the scientific and economical location, construction, operation and maintenance of railways—an influence which has been imparted to the railway world in a degree of usefulness, universal in its scope and almost unparalleled in its import. This feature should be especially gratifying to the members on this particular anniversary. More especially should this appeal to us, as few, if any, kindred bodies have, within the same period or similar length of time, acquired the growth, stability, practical usefulness and, in general, the high standing attained by this association.

In modern days, the science of railway engineering occupies a wide range in the domain of civil engineering in the generic sense. This fact was appreciated even in the early days of railway construction by the compilers of the lexicons of that period, the term "Civil Engineer" being defined by them as "one who plans railways, harbors, docks, etc."—railways apparently being given first place in importance.

From these early days down to the time when the present classification of expenditure was introduced, each railway was practically a law to itself in regard to physical standards, as well as to clerical and accounting methods considered necessary for its proper care.



WILLIAM McNAB,
President, Maintenance of Way Association.

In the course of time, however, the field covered by what is comprehended under the term "railway engineering" became so enlarged and so important that direct supervision in detail from one source was found inadequate, even though the authority enjoyed the broad title of civil engineer.

During that period there was in a more or less degree a lack of proper appreciation of the value of technical education and training as an adjunct to the practical working of the railway, and the results of experiments made from time to time by certain railways individually to establish a justification for proposed changes were, in regard to real value, not altogether satisfactory to the railway world in general. The experience gained from such investigations, desirable or undesirable as the case might be, was often acquired only after the expenditure of large sums of money, direct or indirect, and the ascertained facts were jealously guarded by the interests concerned.

To the railway world, however, the results of such investigations, even if known to be of benefit, did not meet all the requirements essential to a comprehension of what was expedient from an ecomonic standpoint, and the lesson which should have been taught, viz., that as much, if not more, valuable experience is to be acquired through failures rather than from successes, was not properly brought home.

The text books upon particular subjects connected with railway engineering in use in earlier days were produced under private or individual auspices. As a general rule they were ably edited, yet the perspective embraced was circumscribed by reason of existing circumstances, and the value of their use was necessarily limited on account of lack of systematic re-issue of such volumes with supplements to meet changing conditions. Special articles upon railroad technical matters which appeared from time to time lacked the value of full discussion and information thus imparted did not meet requirements, therefore the interest created could only be looked upon as more or less temporary and superficial.

Railway engineering, as a great department of knowledge, eventually came to be so subdivided in order to meet the conditions of the times, that each subdivision practically developed into a distinct science, yet each department retained possession of all the elements tending to form a harmonious whole. Evolution in this respect, however, progressed slowly, and the methods and standards in use were in many instances adhered to too long, partly because their chief recommendation lay in the fact that they were time-honored or that there was a lack of knowledge of better substitutes.

Nowadays, fewer text books on details of railway construction and maintenance emanate from private sources, for the output of your association, viz., the conclusions and principles of practice arrived at by its various committees, which eventually find their way into the Manual of Recommended Practice, have become the source of appeal in their respective spheres. If reference be made to the discussions preceding the adoption of such conclusions and principles of practice to be found in our Proceedings, it will be noted that every detail has been thoroughly covered.

The bibliography of the association is, in consequence, liberally made use of to advantage, not only by the members, but by the executive officers of our railways, as being practically authoritative on railway technical details. In this general connection we are amply justified in stating that there need be no hesitancy in accepting as good modern practice, based upon scientific methods, the general principles which are recommended therein. You are all aware that before any of the various recommendations are adopted and disseminated, they have been thoroughly discussed and voted upon in open convention by the most competent and up-to-date body of railway engineers to be found anywhere, and in no other organization is there a greater degree of care exercised to guard against inconsistencies than is exhibited in our own.

But while there is every reason to be proud of our achievements during these past ten years, we should not rest content, but endeavor to keep our work up-to-date by eliminating from our Recommended Practice what in course of time has become obsolete and perfecting that which is considered worthy of retention, in order that our Recommendations may be safely relied upon as representing the best practice that can be devised for the time being.

In no quarter of the world do the diversities of nature, both physical and climatic, exist in a greater degree than on the North American continent, and for this reason the

problems confronting railway engineers afford ample opportunity for the exercise of that particular knowledge which your association was formed to advance, namely, that pertaining to the scientific location, construction, operation and maintenance of railways.

Great progress has been made in that respect since the formation of the association ten years ago, as will be noted by reference to the historical sketch prepared by the secretary. It is realized more fully that the railway problems coming under our immediate purview are being brought under the influence of common conditions and tendencies.

We meet the propositions which ever present themselves with the knowledge that conditions to-day are not to be governed entirely by the experience acquired in earlier days. It is our endeavor also to realize how in carrying out the objects of the Association, true economics require proper discernment between what is expedient and what is essential, as well as a clear insight into what will tend to the permanent commercial success of the companies by whom we are respectively employed. We are also striving, and not unsuccessfully, for a better understanding of the relationship of capital invested to maintenance and operating expenses. In this respect it is borne in mind, that as the ratio of progress of all kinds is ever increasing, and that as railways are commercial undertakings, the various factors which produce the greatest permanent profit per cent of the expenditure as well as those which have an adverse effect must be carefully studied. We realize more and more the value of a free exchange of experiences and the practical uses that such exchange can be put to as well as the results brought about by scientific analyses of theories that have not yet been put to experimental tests.

Since your last Convention, the Board of Direction, as well as the Association as a whole, has been called upon to sustain a heavy loss in the removal by death of two of its most valued members, namely, your late President, Walter G. Berg, and D. D. Carothers, Member of the Board of Direction. In every department of the Association's interests, with which they were respectively connected, their work was accomplished with a thoroughness that left a deep and lasting impress upon the minds of their colleagues and fellow-members, while their genial personalities endeared them socially to the membership generally. Opportunity will be afforded during this Convention for remarks from members eulogistic of the life and character of both the deceased officers.

Your President having been actively connected with the Association since its inception, desires now to bear testimony to the zeal shown by the officers and directors in shaping the destiny of the Association, and guarding its best interests. Acknowledgement is also made of the earnest devotion of the chairmen, vice-chairmen and members of the committees, and of the members of the Association individually in the work, and it may be accepted as entirely within the limits of modesty if it be said that by reason of the elements just mentioned, the work has been carried on with a degree of perfection that otherwise would have been impossible.

It may also be said that during the past decade, railway construction could not have progressed to the extent and in the manner it has, nor the railways themselves been as efficiently maintained as they have been and are being maintained, if it had not been for the organization and co-operation shoulder to shoulder, individually and collectively of the members of the American Railway Engineering and Maintenance of Way Association.

The Secretary and Treasurer then read his report. The cash balance on hand March 15, 1908, was $15,852. The receipts during the year were $13,078 and expenditures $12,783, leaving a balance to credit of $295. The cash balance on hand March 15, 1909, was $16,147.

The total amount of the impact test fund was $5,582, and the amount expended to date $5,315, leaving a balance on hand of $267.

The membership at the last annual report was 680; members admitted during the year, 120; deceased, 8; resignations, 8; membership March 15, 1909, 784.

The following members died during the year: Walter G. Berg, D. D. Carothers, H. G. Fleming, Theo. Schidlovsky, E. E. Styner, J. W. Leahy, Dennis Sheahan, C. E. Sheriff.

The first report considered was Uniform Rules. An abstract of the report and discussion begins on page 584.

Signaling and Interlocking was next taken up. An abstract of the report and discussion begins on page 586.

The report of the special committee on Brine Drippings from Refrigerator Cars followed. See page 590.

The reports on Yards and Terminals and Rail, were acted on without much discussion and closed the afternoon session. The former is given on page 592, the latter, page 594.

The first part of the evening session was devoted to memorial exercises for the late Walter G. Berg, who was elected President of the Association last year, and D. D. Carothers, member of the Board of Directors and chairman of the Committee on Rail. The speakers were A. W. Johnston (N. Y. C. & St. L.), J. B. Berry (C., R. I. & P.), H. T. Balliet (N. Y. C.), J. P. Snow (B. & M.), E. F. Ackerman (L. V.), C. Frank Allen (Mass. Inst. Tech.), Hunter McDonald (N. C. & St. L.), and W. M. Camp (Ry. & Eng. Review) for Mr. Berg, and L. C. Fritch (I. C.), A. W. Thompson (B. & O.), Earl Stimson (B. & O. S. W.), J. E. Greiner (B. & O.), A. S. Kinsman (B. & O.) and W. C. Cushing (Penna.) for Mr. Carothers. Suitable resolutions were passed.

The report on Track begins on page 597.

The morning session of the second day was opened with the report on Ties. The abstract begins on page 599.

An abstract of the report and discussion on Wooden Bridges and Trestles begins on page 602. In connection with the abstract it should be noted that at a later session of the convention Chairman Jacoby reported that the committee had had another conference relative to the change in designation of "No. 1 R. R. Grade" and "No. 2 R. R. Grade," and had decided to change the ones agreed on with the Yellow Pine Manufacturers' Association to "railroad heart" for first grade and "railroad falsework" for second.

Wood Preservation was then discussed. See page 606.

The report on Ballasting, which was taken up next, and the discussion is abstracted, beginning on page 613.

Records, Reports and Accounts, the last report of the Wednesday session, begins on page 611.

The tenth annual dinner of the Association was held in the banquet hall of the Auditorium Annex, Wednesday evening, March 17. President McNab presided, and the attendance was very large.

The first speaker of the evening was Hon. George W. Ross, ex-Prime Minister of Ontario, who has served thirty-five years in the Canadian Parliament, and is now a senator. Taking the services of the railways in promoting international fellowship as his topic, he delivered an eloquent oration on the national aspects of the transcontinental railways in the United States and Canada, and spoke feelingly of the great railway builders—Van Horne, Shaughnessy and Hays—whom Canada has borrowed from the United States, and of James J. Hill, the great railway builder whom the United States borrowed from Canada.

Blewett Lee, General Attorney for the Illinois Central Railroad, was the next speaker. Mr. Lee expressed his conviction that civil engineering was likely to be considered, *par excellence*, the learned profession before many years. It is founded on mathematics, the invention of the Evil One, to give a taste of what will happen to you in the hereafter if you aren't good! Mr. Lee said there was no other profession which makes such demands on physical strength and moral courage. Civil engineers have every opportunity to graft, but they simply don't do it.

John T. Cade, vice-president of the Federal Signal Company, spoke in humorous vein, but pointed his moral with the lesson of progress in all things. He was followed by Past-President Hunter McDonald, Chief Engineer of the Nashville, Chattanooga & St. Louis, who spoke strongly of the system of straight and honorable promotion by which the Association chose its presidents, and of the services of the Association in promoting good fellowship among civil engineers.

Dr. J. A. Holmes, chief of the Technological Branch of the United States Geological Survey; Colonel H. G. Prout, first vice-president and general manager of the Union Switch & Signal Co.; F. R. Coates, of the Committee on Arrangements;

Captain Azel Ames, of the Kerite Insulated Wire & Cable Co., and L. C. Fritch, Consulting Engineer of the Illinois Central Railroad Co., also made brief addresses, after which a silent toast was drunk to the memory of Mr. Berg and Mr. Carothers, The exercises then came to a close, after singing the American and British national anthems.

The third day's sessions were begun with Signs, Fences, Crossings and Cattleguards, which is given on page 622.

The report on Roadway was considered next. The abstract of the report and discussion begins on page 625.

The report on Buildings, which followed, together with the discussion, is abstracted, beginning on page 628.

The committee on Iron and Steel Structures then submitted its report. Included with this was the report of the subcommittee on Length of Flat Spots on Car Wheels. The abstracts of the report and discussion begin on page 635.

The special committee on Uniform General Contract Forms came next, the report and abstract beginning on page 636.

The last regular report was on Masonry. The abstract and report of the discussion begins on page 637.

The committees on Economics of Railway Location and Electricity submitted progress reports.

Special committees on Conservation of Natural Resources, Standard Specifications for Cement, and to co-operate with the National Advisory Board on Fuels and Structural Materials, also submitted progress reports.

The following officers for the ensuing year were elected:

President, William McNab, Principal Assistant Engineer Grand Trunk.

First Vice-President, L. C. Fritch, Consulting Engineer, Illinois Central.

Second Vice-President, W. C. Cushing, Chief Engineer Maintenance of Way, Pennsylvania Lines, Southwest System.

Secretary, E. H. Fritch.

Treasurer, W. S. Dawley, Chief Engineer, Missouri & North Arkansas.

Members of Board of Directors, three years each, A. H. Rudd, Signal Engineer Pennsylvania Railroad, and A. W. Thompson, Chief Engineer Maintenance of Way, Baltimore & Ohio.

The following are the committees for the ensuing year:

I—Committee on Roadway.

Geo. H. Bremner (Chairman), Engineer Illinois District, Chicago, Burlington & Quincy, Chicago.

S. B. Fisher (Vice-Chairman), Chief Engineer, Missouri, Kansas & Texas.

John C. Beye, Locating Engineer, Chicago, Rock Island & Pacific.

D. J. Brumley, Principal Assistant Engineer, Illinois Central.

Moses Burpee, Chief Engineer, Bangor & Aroostook.

W. C. Curd, Assistant Engineer, Missouri Pacific.

W. M. Dawley, Assistant Engineer, Erie.

Walt Dennis, Office Engineer, Kansas City Southern.

Paul Didier, District Engineer, Baltimore & Ohio.

C. Dougherty, Civil Engineer, New York, N. Y.

A. M. Kinsman, Chief Engineer, Baltimore & Ohio.

D. MacPherson, Assistant Chief Engineer, National Transcontinental.

L. B. Merriam, Division Engineer, Grand Trunk Pacific.

M. P. Paret, Civil Engineer, Kansas City, Mo.

W. D. Pence, Professor of Railroad Engineering, University of Wisconsin.

John C. Sener, Contracting Engineer, Chicago, Ill.

H. J. Slifer, General Manager, Panama Railroad.

J. A. Spielmann, Engineer Maintenance of Way, Baltimore & Ohio.

J. G. Sullivan, Assistant Chief Engineer, Canadian Pacific.

J. E. Willoughby, Engineer of Construction, Louisville & Nashville.

R. C. Young, Chief Engineer, Lake Superior & Ishpeming and Munising Railways.

II—Committee on Ballasting.

John V. Hanna (Chairman), Chief Engineer, Kansas City Terminal Railway.

C. A. Paquette (Vice-Chairman), Assistant Chief Engineer, Cleveland, Cincinnati, Chicago & St. Louis.

O. P. Allee, Assistant Engineer, Kansas City Southern.

F. J. Bachelder, Division Engineer, Baltimore & Ohio.

W. J. Bergen, Assistant to Chief Engineer, New York, Chicago & St. Louis.

J. G. Bloom, District Engineer, Chicago, Rock Island & Pacific.

H. B. Dick, Division Engineer, Baltimore & Ohio.

J. B. Dickson, Assistant to General Manager, Erie.

W. H. Grant, Manager of Construction, Canadian Northern Ontario.

H. E. Hale, Assistant Engineer, Missouri Pacific.

G. D. Hicks, Superintendent, Nashville, Chattanooga & St. Louis.

C. C. Hill, Division Engineer, Michigan Central.

S. A. Jordan, Engineer Maintenance of Way, Baltimore & Ohio.

E. R. Lewis, Division Engineer, Michigan Central.

J. M. Meade, Engineer E. G. D., Atchison, Topeka & Santa Fe.

C. S. Millard, Engineer Maintenance of Way, Cleveland, Cincinnati, Chicago & St. Louis.

R. D. Starbuck, Assistant Chief Engineer, Michigan Central.

F. J. Stimson, Engineer Maintenance of Way, Grand Rapids & Indiana.

G. M. Walker, Jr., Roadmaster, Atchison, Topeka & Santa Fe.

S. N. Williams, Professor of Civil Engineering, Cornell College, Mt. Vernon, Ia.

III—Committee on Ties.

E. B. Cushing (Chairman), Southern Pacific.

E. E. Hart (Vice-Chairman), Chief Engineer, New York, Chicago & St. Louis.

A. F. Dorley, Division Engineer, Missouri Pacific.

W. F. H. Finke, Tie and Timber Agent, Southern.

E. D. Jackson, Assistant Engineer, Baltimore & Ohio.

F. G. Jonah, Terminal Engineer, New Orleans Terminal.

H. C. Landon, Engineer Maintenance of Way, Buffalo & Susquehanna.

A. F. Stewart, Assistant Chief Engineer, MacKenzie-Mann Company, Toronto, Canada.

W. D. Taylor, Chief Engineer, Chicago & Alton.

A. W. Thompson, Chief Engineer Maintenance of Way, Baltimore & Ohio.

Hermann von Schrenk, Supervisor of Timber Preservation, Rock Island, Chicago & Eastern Illinois and Frisco.

G. H. Webb, Chief Engineer, Michigan Central.

H. S. Wilgus, Engineer Maintenance of Way, Pittsburgh, Shawmut & Northern.

IV—Committee on Rail.

Chas. S. Churchill (Chairman—Director), Chief Engineer, Norfolk & Western.

R. Montfort (Vice-Chairman), Consulting Engineer, Louisville & Nashville.

Robert Trimble (Secretary), Chief Engineer Maintenance of Way, Northwest System, Pennsylvania Lines.

E. B. Ashby, Chief Engineer, Lehigh Valley.

J. A. Atwood, Chief Engineer, Pittsburg & Lake Erie.

A. S. Baldwin, Chief Engineer, Illinois Central.

J. B. Berry, Chief Engineer, Chicago, Rock Island & Pacific.

M. L. Byers, Chief Engineer Maintenance of Way, Missouri Pacific.

W. C. Cushing (Director), Chief Engineer Maintenance of Way, Southwest System, Pennsylvania Lines.

F. A. Delano, President, Wabash.

Dr. P. H. Dudley, Rail Expert, New York Central.

C. H. Ewing, Engineer Maintenance of Way, Philadelphia & Reading.

John D. Isaacs, Consulting Engineer, Harriman Lines.

Thos. H. Johnson, Consulting Engineer, Pennsylvania Lines.

Howard G. Kelley (Past-President), Chief Engineer, Grand Trunk System.

J. W. Kendrick, Second Vice-President, Atchison, Topeka & Santa Fe.

George W. Kittredge (Past-President), Chief Engineer, New York Central.

D. W. Lum, Chief Engineer Maintenance of Way and Structures, Southern.

Jos. T. Richards, Chief Engineer Maintenance of Way, Pennsylvania Railroad.

J. P. Snow (First Vice-President), Bridge Engineer, Boston & Maine.

A. W. Thompson, Chief Engineer Maintenance of Way, Baltimore & Ohio.

V—Committee on Track.

L. S. Rose (Chairman), Signal Engineer, Cleveland, Cincinnati, Chicago & St. Louis.

C. E. Knickerbocker (Vice-Chairman), Engineer Maintenance of way, New York, Ontario & Western.

E. C. Blundell, General Roadmaster, Chicago, St. Paul, Minneapolis & Omaha.
Garrett Davis, Superintendent, Chicago, Rock Island & Pacific.
T. H. Hickey, Roadmaster, Michigan Central.
R. H. Howard, Engineer Maintenance of Way, Chicago & Eastern Illinois.
C. B. Hoyt, Superintendent Track, New York, Chicago & St. Louis.
J. B. Jenkins, Assistant Engineer, Baltimore & Ohio.
John R. Leighty, Division Engineer, Missouri Pacific.
C. E. Lindsay, Engineer Maintenance of Way, Electric Zone, New York Central.
J. C. Nelson, Engineer Maintenance of Way, Seaboard Air Line.
P. C. Newbegin, Maintenance Engineer, Bangor & Aroostook.
H. T. Porter, Chief Engineer, Bessemer & Lake Erie.
G. J. Ray, Chief Engineer, Delaware, Lackawanna & Western.
Wm. G. Raymond, Dean State University of Iowa, Iowa City, Ia.
S. S. Roberts, Assistant Professor of Railroad Engineering University of Illinois, Urbana, Ill.
F. A. Smith, Civil Engineer, Chicago, Ill.
W. D. Wheeler, Chief Engineer, Minneapolis & St. Louis.
A. A. Wirth, Engineer Maintenance of Way, Pennsylvania Lines.

VI—Committee on Buildings.

O. P. Chamberlain (Chairman), Chief Engineer, Chicago & Illinois Western.
Maurice Coburn (Vice-Chairman), Engineer Maintenance of Way, Vandalia Line.
Geo. W. Andrews, Inspector of Maintenance, Baltimore & Ohio.
H. M. Cryder, Fullerton Building, St. Louis, Mo.
Wm. T. Dorrance, Designing Engineer, New York Central.
C. H. Fake, Chief Engineer, Mississippi River & Bonne Terre.
P. F. Gentine, Division Engineer, Missouri Pacific.
E. N. Layfield, Chief Engineer, Chicago Terminal Transfer.
M. A. Long, Architect, Baltimore & Ohio.
John S. Metcalf, Civil Engineer, Chicago, Ill.
L. D. Smith, Engineering Department, Southern Pacific.
C. H. Stengel, Designing Engineer, Virginian.

VII.—Committee on Wooden Bridges and Trestles.

H. S. Jacoby (Chairman), Professor of Bridge Engineering, Cornell University.
James Keys (Vice-Chairman), Assistant Engineer, Union Pacific.
F. H. Bainbridge, Resident Engineer, Chicago & Northwestern.
W. S. Bouton, Engineer of Bridges, Baltimore & Ohio.
Geo. A. Casseday, Bridge Engineer, Great Northern.
R. D. Coombs, Structural Engineer, Pennsylvania Tunnel & Terminal.
Wm. Graham, Assistant Engineer, New York, New Haven & Hartford.
L. J. Hotchkiss, Assistant Bridge Engineer, Chicago, Burlington & Quincy.
Hans Ibsen, Bridge Engineer, Michigan Central.
J. A. Lahmer, Principal Assistant Engineer, Kansas City Southern Railway.
F. B. Scheetz, Superintendent of Bridges, Missouri Pacific.
W. F. Steffens, Engineer of Bridges and Buildings, C. C. & O.
E. G. Taber, Chief Engineer, Spokane International.
G. R. Talcott, Resident Engineer, Georgia & Florida.
C. C. Wentworth, Principal Assistant Engineer, Norfolk & Western.
P. H. Wilson, Civil Engineer, Devon, Pa.

VIII.—Committee on Masonry.

A. O. Cunningham (Chairman), Chief Engineer, Wabash.
W. H. Petersen (Vice-Chairman), Bridge Engineer, Chicago, Rock Island & Pacific.
W. J. Backes, Chief Engineer, Central New England.
G. J. Bell, Division Engineer, Atchison, Topeka & Santa Fe.
C. W. Boynton, Inspecting Engineer, Universal Portland Cement Company.
W. H. Chadbourn, Chief Engineer, Chicago Great Western.
W. W. Colpitts, Chief Engineer, Kansas City, Mexico & Orient.
T. L. Condron, Consulting Engineer, Chicago, Ill.
B. Douglas, Tunnel Engineer, Detroit River Tunnel.
L. N. Edwards, Assistant Engineer, Grand Trunk.
Richard L. Humphrey, Consulting Engineer, Philadelphia.
C. H. Moore, Engineer of Grade Crossings, Erie.
J. W. Schaub, Consulting Engineer, Chicago, Ill.
G. H. Scribner, Jr., Consulting Engineer, Chicago, Ill.
A. N. Talbot, Professor Mining and Sanitary Engineering, University of Illinois, Urbana, Ill.
G. H. Tinker, Bridge Engineer, New York, Chicago & St. Louis.
Job Tuthill, Engineer Bridges and Bldgs., Pere Marquette.

IX.—Committee on Signs, Fences, Crossings and Cattle-Guards.

W. D. Williams (Chairman), Chief Engineer, Cincinnati Northern.
K. J. C. Zink (Vice-Chairman), Assistant Engineer, Grand Trunk Pacific.
A. G. Boughner, Office Chief Draftsman, Baltimore & Ohio.
A. E. Douget, District Engineer, Transcontinental Railway.
A. M. Funk, Division Engineer, Baltimore & Ohio.
Paul Hamilton, Engineer Maintenance of Way, Cleveland, Cincinnati, Chicago & St. Louis.
C. W. Johns, Assistant Engineer, Chesapeake & Ohio.
H. L. Laughlin, Engineer Maintenance of Way, Minneapolis, St. Paul & Sault Ste. Marie.
J. W. Orrock, Chief Draftsman, Canadian Pacific.
P. Pietri, Division Engineer, Baltimore & Ohio.
R. O. Rote, Principal Assistant Engineer, Lake Shore & Michigan Southern.
C. H. Stein, Engineer Maintenance of Way, Central Railroad of New Jersey.

X.—Committee on Signaling and Interlocking.

A. H. Rudd (Director-Chairman), Signal Engineer, Pennsylvania Railroad.
L. R. Clausen (Vice-Chairman), Superintendent, Chicago, Milwaukee & St. Paul.
Azel Ames, Kerite Insulated Wire & Cable Company.
C. C. Anthony, Assistant Signal Engineer, Pennsylvania R. R.
N. E. Baker, Signal Engineer, Illinois Central.
H. S. Balliett, Engineer of Maintenance of Way, New York Central.
H. S. Cable, General Superintendent, Construction Department, Chicago, Rock Island & Pacific.
C. A. Christofferson, Signal Engineer, Northern Pacific.
C. E. Denney, Signal Engineer, Lake Shore & Michigan Southern.
W. H. Elliott, Signal Engineer, New York Central.
G. E. Ellis, Federal Signal Company, Albany, N. Y.
W. J. Harahan, Assistant to President, Erie.
M. H. Hovey, Homewood, Ill.
A. S. Ingalls, Assistant General Superintendent, Lake Shore & Michigan Southern.
J. C. Mock, Electrical Engineer, Detroit River Tunnel Co.
F. P. Patenall, Signal Engineer, Baltimore & Ohio.
J. A. Peabody, Signal Engineer, Chicago & Northwestern.
Frank Rhea, General Electric Co., Schenectady, N. Y.
W. B. Scott, Assistant Director Maintenance and Operation, Harriman Lines.
Thos S. Stevens, Signal Engineer, Santa Fe System.
J. E. Taussig, Terminal Superintendent, Wabash.
H. H. Temple, Superintendent, Baltimore & Ohio.

XI.—Committee on Record, Reports and Accounts.

H. R. Safford (Chairman), Chief Engineer Maintenance of Way, Illinois Central.
H. J. Pfeifer (Vice-Chairman), Engineer Maintenance of Way, Terminal Railroad Association of St. Louis.
S. D. Brady, Chief Engineer, Little Kanawha.
J. M. Brown, District Engineer, Chicago, Rock Island & Pac.
M. C. Byers, Chief Engineer, St. Louis & San Francisco.
A. L. Davis, Assistant Engineer, Illinois Central.
T. H. Gatlin, Engineer Maintenance of Way, Southern.
C. H. Gerber, Resident Engineer, Union Pacific.
Edward Gray, Engineer Maintenance of Way, Southern.
E. E. Hanna, Division Engineer, Missouri Pacific.
O. L. Holman, Assistant Engineer, Maintenance of Way, Great Northern.
Paul Jones, Superintendent, Cincinnati & Muskingum Valley.
Henry Lehn, Maintenance of Way Accountant, New York Central.
J. H. Milburn, Chief Draftsman, Baltimore & Ohio.
G. L. Moore, Engineer Maintenance of Way, Lehigh Valley.
A. G. Norton, Resident Engineer, Erie.
C. W. Pifer, Roadmaster, Illinois Central.
J. F. Schwed, Lake Shore & Michigan Southern.
W. H. Sellew, Principal Assistant Engineer, Michigan Cent.
V. D. Simar, Acting Chief Engineer, Duluth, South Shore & Atlantic.
J. E. Turk, Superintendent, Philadelphia & Reading.
R. W. Willis, Engineer, Missouri District, Chicago, Burlington & Quincy.
W. P. Wiltsee, Assistant Engineer, Norfolk & Western.

XII.—Committee on Uniform Rules.

Jos. O. Osgood (Chairman), Chief Engineer, Central Railroad of New Jersey.
F. L. Nicholson (Vice-Chairman), Engineer Maintenance of Way, Norfolk & Southern.
C. C. Anthony, Assistant Signal Engineer, Pennsylvania R. R.
G. D. Brooke, Assistant Engineer, Baltimore & Ohio.
W. H. Elliott, Signal Engineer, New York Central.
C. N. Kalk, Chief Engineer, Wisconsin Central.
G. L. Moore, Engineer Maintenance of Way, Lehigh Valley.
J. B. Myers, Division Engineer, Baltimore & Ohio.
J. A. Peabody, Signal Engineer, Chicago & Northwestern.

XIII.—Committee on Water Service.

C. L. Ransom (Chairman), Resident Engineer, Chicago & Northwestern.
M. H. Wickhorst (Vice-Chairman), Engineer of Tests, Chicago, Burlington & Quincy.
J. L. Campbell, Engineer Maintenance of Way, El Paso & Southwestern.
Robert Ferriday, Engineer Maintenance of Way, Cleveland, Cincinnati, Chicago & St. Louis.
G. H. Herrold, Division Engineer, Chicago Great Western.
E. G. Lane, Engineer Maintenance of Way, Baltimore & Ohio.
A. S. Markley, Master Carpenter, Chicago & Eastern Illinois.
C. A. Morse, Chief Engineer, Atchison, Topeka & Santa Fe.
L. P. Rossiter, Division Engineer, Baltimore & Ohio.
A. D. Schermerhorn, Division Engineer, Union Pacific.

XIV—Committee on Yards and Terminals.

F. S. Stevens (Chairman), Superintendent, Philadelphia & Reading.
E. E. R. Tratman (Vice-Chairman), Resident Editor, Engineering News, Chicago, Ill.
Hadley Baldwin, Superintendent, Cleveland, Cincinnati, Chicago & St. Louis.
W. C. Barrett, Division Engineer, Baltimore & Ohio.
G. H. Burgess, Engineer Terminal Improvements, Erie.
L. G. Curtis, Division Engineer, Baltimore & Ohio.
A. H. Dakin, Jr., Engineer, Chicago, Milwaukee & St. Paul.
H. T. Douglas, Jr., Chief Engineer, Wheeling & Lake Erie.
A. C. Everham, Assistant Tunnel Engineer, Detroit River Tunnel Co.
M. J. Henoch, Assistant Engineer, Louisville & Nashville.
H. A. Lane, Assistant Engineer, Baltimore & Ohio.
B. H. Mann, Signal Engineer, Missouri Pacific.
A. Montzheimer, Chief Engineer, Elgin, Joliet & Eastern.
G. F. Morse, Assistant Engineer, Central Railroad of New Jersey.
W. L. Seddon, Chief Engineer, Seaboard Air Line.
C. S. Sims, Vice-President, Delaware & Hudson.
W. E. Dauchy, Division Engineer, Chicago, Milwaukee & St. Paul.
A. C. Dennis, Assistant Engineer, Canadian Pacific Railway.
P. M. LaBach, Assistant Office Engineer, Chicago, Rock Island & Pacific.
C. J. Parker, Principal Assistant Engineer, New York Central.
J. E. Schwitzer, Assistant Chief Engineer, Canadian Pacific.
Francis Lee Stuart, Chief Engineer, Erie.
W. L. Webb, Consulting Engineer, Philadelphia, Pa.

XVII.—Committee on Wood Preservation.

W. K. Hatt (Chairman), Professor Civil Engineering, Purdue University, Lafayette, Ind.
R. N. Begien (Vice-Chairman), Assistant Engineer, Baltimore & Ohio.
E. H. Bowser, Chief Timber Inspector, Illinois Central.
Lincoln Bush, Consulting Engineer, New York, N. Y.
O. Chanute, Consulting Engineer, Chicago, Ill.
C. K. Conard, Assistant Engineer, Erie.
W. H. Courtenay, Chief Engineer, Louisville & Nashville.
C. G. Crawford, General Manager, American Creosoting Company, Chicago, Ill.
E. B. Cushing, Southern Pacific.
W. W. Curtis, Consulting Engineer, Chicago, Ill.
G. M. Davidson, Chemist, Chicago & Northwestern.
E. O. Faulkner, Manager Tie and Timber Department, Santa Fe System.
V. K. Hendricks, Assistant Engineer Maintenance of Way, St. Louis & San Francisco.
R. L. Huntley, Chief Engineer, Union Pacific.
A. L. Kuehn, General Superintendent, American Creosoting Company.
S. M. Rowe, Consulting Engineer, Chicago, Ill.
Earl Stimson, Chief Engineer Maintenance of Way, Baltimore & Ohio Southwestern.
Hermann von Schrenk, Supervisor of Timber Preservation, Rock Island, Frisco and Chicago & Eastern Illinois.
Howard F. Weiss, Forest Service, United States Department of Agriculture, Washington, D. C.
C. H. Spencer, Engineer, Washington Terminal Company.
C. H. Stein, Engineer Maintenance of Way, Central Railroad of New Jersey.
A. Swartz, Division Engineer, Erie.

XV—Committee on Iron and Steel Structures.

J. E. Greiner (Chairman), Consulting Engineer, Baltimore, Md.
C. F. Loweth (Vice-Chairman), Engineer and Superintendent of Bridges and Buildings, Chicago, Milwaukee & St. Paul.
J. C. Bland, Engineer of Bridges, Pennsylvania Lines West.
C. H. Cartlidge, Bridge Engineer, Chicago, Burlington & Quincy.
C. L. Crandall, Professcr Railway Engineering, Cornell University.
B. W. Guppy, Bridge Engineer, Maine Central.
A. J. Himes, Assistant Chief Engineer, New York, Chicago & St. Louis.
Chas. M. Mills, Principal Assistant Engineer, Philadelphia Elevated Railroad & Subway.
A. D. Page, Principal Assistant Engineer, Chicago, Rock Island & Pacific.
C. D. Purdon, Consulting Engineer, St. Louis & San Francisco.
A. F. Robinson, Bridge Engineer, Santa Fe System.
C. C. Schneider, Consulting Engineer, Philadelphia, Pa.
F. E. Turneaure, University of Wisconsin, Madison, Wis.
W. R. Webster, Consulting Engineer, Philadelphia, Pa.

XVI—Committee on Economics of Railway Location.

A. K. Shurtleff (Chairman), Office Engineer, Chicago, Rock Island & Pacific.
C. Frank Allen (Vice-Chairman), Professor Railroad Engineering, Massachusetts Institute Technology.
R. N. Begien, Assistant Engineer, Baltimore & Ohio.
W. Beahan, Assistant Engineer, Lake Shore & Michigan Southern.
J. F. Burns, Roadmaster, Louisville & Nashville.
W. L. Darling, Chief Engineer, Northern Pacific Railway.
C. C. Anthony, Assistant Signal Engineer, Pennsylvania R. R.
of Bridges and Buildings, Chicago, Milwaukee & St. Paul.
W. E. Dauchy, District Engineer, Chicago, Milwaukee & Puget Sound.
A. C. Dennis, Assistant Engineer, Canadian Pacific.
L. B. Merriam, Division Engineer, Grand Trunk Pacific.
C. J. Parker, Principal Assistant Engineer, New York Central.
Walter Loring Webb, Consulting Engineer, Philadelphia.

Special Committee on Uniform General Contract Forms.

E. F. Ackerman (Chairman), Assistant Engineer, Lehigh Valley.
J. C. Irwin (Vice-Chairman), Office Engineer, New York Central.
Wm. Archer, Real Estate Agent, Baltimore & Ohio Southwestern.
W. L. Breckinridge, Engineer Maintenance of Way, Chicago, Burlington & Quincy.
W. G. Brimson, Vice-President and General Manager, Quincy, Omaha & Kansas City.
W. S. Kinnear, Assistant General Manager, Michigan Central.
Fred Lavis, Resident Engineer, Pennsylvania Tunnel & Terminal.
E. H. Lee, Chief Engineer, Chicago & Western Indiana.
W. B. Storey, Jr., Chief Engineer, Santa Fe System.
W. F. Tye, Civil Engineer, Montreal, Canada.
C. A. Wilson, Chief Engineer, Cincinnati, Hamilton & Dayton.

XVIII—Committee on Electricity.

Geo. W. Kittredge (Past-President-Chairman), Chief Engineer, New York Central.
J. B. Austin, Jr. (Vice-Chairman), Engineer Maintenance of Way, Long Island.
A. S. Baldwin, Chief Engineer, Illinois Central.
R. D. Coombs, Structural Engineer, Pennsylvania Tunnel & Terminal.
E. P. Dawley, Engineer of Construction, New York, New Haven & Hartford.
L. C. Fritch (Second Vice-President), Consulting Engineer, Illinois Central.
G. A. Harwood, Chief Engineer, Electric Zone Improvements, New York Central.
W. W. Drinker, Assistant Engineer, Erie.
C. E. Lindsay, Division Engineer, New York Central.
H. R. Talcott, Engineer Surveys, Baltimore & Ohio.

REPORTS AND DISCUSSIONS, MAINTENANCE OF WAY CONVENTION.

UNIFORM RULES, ORGANIZATION, TITLES, CODE, ETC.

The committee was instructed to report on the following subjects:

(1) Supplement "General Rules for Government of Employees of the Maintenance of Way Department."

(2) Prepare special rules for foremen and other employees, properly grouped and classified in accordance with and supplementary to the general rules heretofore adopted.

The following additions were submitted for incorporation in the "General Rules":

"Anything that interferes with the safe passage of trains at full speed is an obstruction.

"Employees must exercise the greatest care and watchfulness to prevent injury or damage to persons or property; in case of doubt, they must take the safe course and run no risk.

"Co-operation is required between all employees whose work or duties may be jointly affected."

The following rules governing track foremen, bridge and building foremen, and signal foremen were submitted for approval:

Rules Governing Track Foremen, Bridge and Building Foremen, and Signal Foremen.

TRACK FOREMEN.

(1) Track Foremen shall report to and receive instructions from the .....(Title).....

(2) They shall be responsible for the proper inspection and safe condition of the track under their charge, and shall do no work thereon that will interfere with the safe passage of trains, except under proper protection.

(3) They must go over their sections, or send a reliable man, at least once a day to make a thorough inspection to see that the track, signals, culverts, bridges, fences, etc., are in safe condition.

(4) If the track or any bridge or culvert, in the judgment of the Track Foreman, is not safe, he must at once put out the proper signals to warn approaching trains and immediately notify the .....(Title)..... of its condition, and do all in his power to repair the defect.

(5) During heavy storms, whether by day or night, whereby the track, or any portion of the company's property, becomes liable to damage, foremen and trackmen must be on duty; and at such times they must go over their sections to make sure that the track is safe, taking danger signals with them.

(6) They must use constant care to see that all waterways are kept free from obstructions.

(7) They must have a copy of the current timetable, and be thoroughly familiar with the rules and regulations thereon, and with the time of trains over their sections. They must carefully observe signals displayed by all trains, and assure themselves before obstructing track that all trains and sections due have passed. No notice will be given of extra trains, and trackmen must protect themselves as prescribed by the Book of Rules. They must provide themselves with reliable watches, and compare time daily with a standard clock or with conductors.

(8) In case of accident, they must at once render all assistance in their power, whether the accident occurs on their own or on an adjoining section.

(9) They must permit no encroachment upon or occupancy of any portion of the company's right-of-way, except by proper authority.

(10) They shall employ such men as the .....(Title)..... will direct, and see that they properly perform their duties. They must keep the required record of the time of their men and of the material used.

(11) They must keep a careful lookout for fires along the track, and prevent, if possible, the destruction of fences, wood or other material, and the spread of fire into adjoining fields. During dry weather they must not permit fires to be started unless they have sufficient force to keep them under control.

(12) They must keep the vicinity of all bridges and trestles cleared of all combustible material, such as chips, bark, dried grass, etc. They must keep bridge seats, tops of piers, and bottom chords cleaned of all cinders and dirt. Where water barrels are furnished, they must keep them filled with water.

(13) They must limit the use of handcars to the service of the company; and they must not permit anyone except employees of the company engaged in the performance of duty to ride thereon, except by proper authority. They must not permit the running of hand or velocipede cars belonging to private parties over the tracks of the company, except by proper authority.

BRIDGE AND BUILDING FOREMEN.

(1) Bridge and Building Foremen shall report to and receive instructions from the .....(Title).....

(2) They shall be held responsible for the proper inspection and safe condition of the structures under their charge, and shall do no work thereon that will interfere with the safe passage of trains, except under proper protection.

(3) They must have a copy of the current timetable, and be thoroughly familiar with the rules and regulations thereon, and with the time of trains over their district. They must provide themselves with reliable watches, and compare time daily with a standard clock or with conductors.

(4) They shall employ such men as the .....(Title)..... will direct, and must see that they properly perform their duties. They must keep the required record of the time of their men and of the material used.

SIGNAL FOREMEN.

(1) Signal Foremen shall report to and receive instructions from the .....(Title).....

(2) They shall be responsible for the proper condition of signals and interlocking plants under their charge, and shall do no work thereon that will interfere with the safe passage of trains, except under proper protection.

(3) They must have a copy of the current timetable, and be thoroughly familiar with the rules and regulations thereon, and with the time of trains over their territory. They must provide themselves with reliable watches, and compare time daily with a standard clock or with conductors.

(4) They shall employ such men as the .....(Title)..... will direct, and must see that they properly perform their duties. They must keep the required record of the time of their men and of the material used.

(5) In case of accident affecting any portion of the signal or interlocking apparatus under their charge, they must at once proceed to the spot with the men, tools and materials necessary to make repairs.

(6) They must investigate and report on the forms provided for the purpose all failures of signals and interlocking plants in their territory.

Conclusions.

(1) Your committee recommends the adoption of the additions to the "General Rules" for publication in the Manual of Recommended Practice.

(2) Your committee recommends the adoption of the Rules Governing Track Foremen, Bridge and Building Foremen, and Signal Foremen for publication in the Manual of Recommended Practice.

The report is signed by R. C. Barnard (Penn. Lines), Chairman; F. L. Nicholson (Norf. & Sou.), Vice-Chairman; G. D. Brooke (B. & O.), W. H. Grant (Can. Nor.), R. L. Huntley (U. P.), C. N. Kalk (W. C.), G. L. Moore (Rutland), J. B. Myers (B. & O.), Jos. O. Osgood (C. R. R. of N. J.), J. A. Peabody (C. & N. W.), J. H. Wallace (Cons. Eng), and C. A. Wilson (C., H. & D.).

The undersigned approved the report, except Rule 3, under Track Foreman, exception being taken to the authority given the track foreman to delegate the daily inspection of track to another man.

G. H. Webb (M. C.).

Discussion.

The chair extended the privileges of the floor to railway officials not members of the association and to college professors to take part in the discussions.

Mr. Barnard: It might be well to say that the greatest difficulty this committee has encountered has been in determining where to draw the line between rules that are sufficiently in detail to cover all the essential points in this department and still be applicable to the majority of roads members of this association, and to exclude such less important rules as you generally find in the small books issued by the various roads for the government of maintenance of way employees and it may be that this association will think that we have not drawn the line in the proper place and have gone too much or too little into detail.

The secretary read the report by clauses.

The President: It will be taken for granted that if there be no objection offered as the clauses are read they will be accepted. The question now is on allowing these clauses to

be incorporated in the Manual of Recommended Practice, and the General Rules.

A vote was taken upon clauses two and three of the report and the same were adopted.

L. C. Fritch (I. C.): Mr. President, I think the word "safe" in the last line of clause 5 ought to read "proper condition." It is the duty of the inspector to see that the condition is proper, as well as safe. I move that the word "safe" be changed to "proper."

The motion was lost.

A. W. Johnston (N. Y. C. & St. L.): It seems to me there is a question as to the requirement in clause 7 that the section foreman must provide himself with a reliable watch. We don't require that in the sense that we simply require them to have their watches examined, and make it an absolute part of their duties under the rules. If, for some reason, he fails to provide himself with a reliable watch, and owing to that failure something happens to bind or make the company liable, it is a serious matter and it is something that we ought to consider carefully.

E. R. Lewis (M. C.): I would move that the word "watches" be added after the last word "conductor."

Mr. Barnard: The committee will accept that.

C. E. Lindsay (N. Y. C.): The word "conductor," is peculiar. We require our supervisors to carry guaranteed watches and the section foremen are privileged to compare their watches with the supervisor's watch.

Mr. Barnard: The idea in preparing that rule was that the supervisor might not be available every day and the section foreman can always find some conductor on a train going by with whom he can compare his watch.

E. R. Lewis (M. C.): I move that the word "adjoining," clause 8, be changed to "and others." There are cases when the foreman is called upon to go further away than adjoining sections.

Mr. Barnard: We accept that suggestion.

Mr. Lindsay: I would like to ask with regard to the first line, clause 10, "they shall employ such men as, etc.,"—does that mean such number of men, or does that relieve the foreman of the responsibility of employing the men, selecting the men and placing upon the officer whose title is omitted the responsibility, or does it mean such men or the kind of men?

Mr. Barnard: Both.

Mr. Lindsay: That relieves the section foreman of the duty of employing his own men.

Mr. Barnard: No, this is the section foreman. His chief will tell him how many men to put on his section and he knows from his general instructions what kind of men to employ, as to their physical ability and so forth.

V. K. Hendricks (St. L. & S. F.): In clause 12 I move that "floor beams and stringers" be added.

Mr. Barnard: If you adopt that, where are you going to stop? You can go into more details and specify other things that they should be kept clear of.

Mr. Hendricks: Then amend by saying "all portions of steel bridges." I think all portions should be kept clean.

The President: Do you mean such portions of the bridge as come directly within the easy access of section foreman?

Mr. Hendricks: Yes sir.

Mr. Hendricks' motion was lost.

C. H. Ewing (P. & R.): I would suggest that we eliminate the detail parts for the reason that bottom chords are specified, and on the deck of the bridge the top chords are more accessible than the bottom. I would suggest that the rule read, "they must keep all accessible parts of bridges clear of cinders and dirt."

Hunter McDonald (N. C. & St. L.): I hardly think the gentleman expects a section foreman to climb up on top of top chords. They are accessible to a bridge man but not to a section foreman.

J. P. Snow (B. & M.): I think the idea of Mr. Ewing is good, that is, leave out details. We cannot draw the line exactly where the section foreman should leave off and the bridge crew come in. It would either be better to cut out all reference to chords and confine the work to masonry or else endeavor to draw a very precise line, which would be a difficult proposition to cover all structures. If we cut out the reference to bottom chords, and so forth, it sems to me it would be all right. I would suggest that to Mr. Ewing.

Mr. Barnard: The committee would accept that.

The President: Do I understand then that it will read "They must keep bridge seats, tops of piers, and so forth, cleaned of all cinders and dirt?"

Mr. Ewing: Yes.

Mr. President: The change is ordered.

Objection was raised by a member.

M. L. Byers (Mo. P.): I would like to ask if the committee would accept the words "readily accessible portions" as a substitute for "and so forth?"

Mr. McDonald: I believe the vote was taken without a full understanding of the situation. I desire to record my protest against any rule which would relieve the section foreman of the duty of cleaning the locomotive sparks off of the iron work of bridges. There is no more potent destroyer of iron work than locomotive cinders and water. It should be the duty of the track walker and section man, and in my judgment should not be confined to sweeping off the masonry. It does not do much harm on the masonry, but it does do a lot of harm on the horizontal members of the steel structure.

Mr. Byers' motion was adopted.

J. B. Berry (C., R. I. & P.): I would like to go back to paragraph 9, after the words "company's right-of-way," and insert at that place the words "and station grounds." Maintenance of way employees draw a marked line as between the company's right-of-way and the station grounds, and if the matter is called to their attention I think they would give more care to it. If there is any one thing on the company's property that requires care from encroachment, it is at the station.

Mr. Barnard: I would ask if we are not encroaching a little bit on the territory of the agent? I think the agent should keep people off his own station grounds. These are instructions for the section foreman.

L. C. Fritch (I. C.): It seems to me that is the very reason why it should be put in, because the section foreman thinks it is the duty of the agent to watch the station grounds, and if we put it in the rules, it makes it the duty of the section foreman. I think it is a very important matter and hope it will be introduced into the rules.

Mr. Berry: With all the care of the section foreman and station agent we are all of us losing property. I have known of many cases where people have been allowed to encroach upon railroad property, even business men in the town, and after the lapse of a few years they claim it as their own property.

The amendment was adopted.

The secretary read the first, second and third sections under "Bridge and Building Foremen."

H. R. Safford (I. C.): Rule 3 is only applicable to bridge foremen, and involves precautionary measures with reference to track construction. It seems to me that the same features should be incorporated in that rule as appear in rule 7 under "Track Foremen." A motion is therefore offered that rule 3 under "Bridge and Building Foremen" be amended, first, by eliminating the word "they" and substituting "bridge foremen" in the first line and making the balance of rule 3 the same as rule 7 under track foremen.

The motion was lost.

M. L. Byers (Mo. Pac.): I am very much in favor of making our rules of such a character that they can be rigidly enforced. Therefore, I move to amend the last sentence of this paragraph 3 by making it read: "They must provide themselves with reliable watches, and when possible compare time daily with a standard clock or conductor's watch."

The motion was adopted and rule 7 under "Track Foremen" changed to read the same.

The remaining rules were read without change.

W. J. Eck (So.): I would suggest to the committee that there be one aditional rule provided, to the effect that the signal foremen must not make any permanent rearrangement in signals or interlocking plants without proper authority.

The President: The committee accepts that and will incorporate it in their report.

E. F. Wendt (P. & L. E.), who is looking after the interests of the Manual of Recommended Practice since the death of Walter G. Berg, called attention to the need of harmonizing the phraseology in all matter intended for the Manual, indicating modifications that would be necessary in these rules before their incorporation therein. He also suggested the advisability of grouping under one heading in the Manual all of the rules applicable to men of the same official grade as foremen, for example.

W. C. Cushing (Penna.): I would like to say a word before the members vote on the adoption of these rules, and that is that they should ask themselves the question, "Will I make use of these rules when I go back home, in formulating my rules for the organization of a maintenance of way department?" It is a very pertinent question and it is our desire to have such matters in our Proceedings as we can stand by and make use of as much as possible.

The President then put the question on the adoption of the rules as amended, which was carried.

SIGNALING AND INTERLOCKING.

This committee consists of 19 members, nearly all of whom are also members of the Railway Signal Association and of Committee No. II of that association. The present report consists largely of matter which was adopted by the Signal Association at its annual meeting last October.

The first thing in this report is a proposed standard agreement for use where two or more roads join in the construction and operation of an interlocking plant. The committee presents a form of agreement filling four pages, but offers this only as a guide for discussion, believing that before the proposed agreement is adopted, parts of it should be considered and acted on by the Railway Signal Association. The conclusions of this report, unanimously agreed upon by the committee, are:

(1) That existing agreements should be given due consideration in the form of arbitraries in the division of construction, renewal, maintenance and operating expenses.
(2) That the proper division of construction, renewal and maintenance expenses is on an operated-unit basis, each party paying for what is required to interlock its tracks, or the residue, where there are existing agreements requiring fixed arbitraries.
(3) The primary operating expense, or the residue after deducting such arbitraries as may be required by existing agreements, should be equally divided among the several parties interested. Where operating expenses are increased by facilities for the exclusive use of one party, such party for whose benefit such facilities are provided should pay the entire additional operating expense.

The form of agreement presented is for an interlocking at an existing crossing, Class A. For a crossing of a new line with an old one, Class B, another form, should be used, and for a crossing of two roads, both new, Class C, still another form would be necessary.

Switchstands.

The committee makes no recommendation on this subject (No. 6) believing that it should wait until a scheme of aspects for signals is adopted.

Manual.

It is also recommended that there be no revision of the Manual until the aspects have been agreed upon, except such as may be made necessary by the specifications and standards which the association may adopt this year.

Symbols.

The sub-committee on this subject has conferred with a sub-committee of No. XI on records, and blueprints of revised symbols were considered; but this committee cannot finally approve these until the question of aspects of signals has been settled.

Specifications for Mechanical Interlocking.

Specifications in this department were adopted in 1907, the same having been adopted by the Railway Signal Association in 1906. Since then the Signal Association has revised the code and, as revised, the committee now presents it in full.

The first part of this report deals with drawbridge protection, but the committee found itself unable to recommend standard apparatus or methods of locking; neither any uniform arrangement of signals, present practice being so diverse. The locking required should be

(a) To insure that the bridge is in proper alinement.
(b) To insure that all bridge surfacing devices are in their proper position.
(c) To lock each rail in proper position for train movement.
(d) To prevent the application of power for purpose of withdrawing bridge latch or opening draw.

FACING-POINT LOCKS.

The committee can find nothing better than "bolt locking" to insure that a switch has responded to the position of the lever. This apparatus should be called a detector lock. With trailing switches and with slow speed signals the expense of bolt locking is not warranted.

The committee then goes on to present its new specifications. These, as revised by the Signal Asociation, are much more full and complete than those heretofore adopted by the Maintenance of Way Association, and the old and the new are printed side by side for comparison. The preliminary clauses, paragraphs 1 to 19 inclusive, have been copied from the specifications for electric interlocking; this in recognition of the desirability of having the two codes alike so far as practicable. The rest of the paragraphs were adopted unanimously by the R. S. A. committee and agreed to by the manufacturer's representatives, who met with the committee.

The Maintenance of Way Association committee, in recommending the adoption of these specifications in place of those heretofore adopted, says that very likely slight amendments will be necessary in the next two or three years.

Specifications for Electric Interlocking.

The committee here presents the specifications adopted by the Signal Association on the recommendation of that association's committee No. III. These specifications are embodied in 130 sections. Under section No. 60 (switches) the committee had much discussion concerning lock rods. The committee has felt that the financial side of any radical change in construction of lock rods which would make necessary a change in switch and lock movements should be handled with due deliberation. The committee feels that there should at this time be given a full consideration of the substitution of some form of hard metals, with a proper adjustable feature, in the locking faces of plunger and rod rather than a radical change in structure. The subject, a vital one, can be viewed as of somewhat the same importance in its line as is that of the frog point in track work where hard metals are now being tested.

Section 130, dealing with drawbridges, is as follows:

At least one lever of the interlocking machine, called the bridge lock lever, shall be assigned for the purpose of locking the bridge. The bridge lock lever when reversed, shall be arranged to lock the bridge in the closed position and to prevent the application of power for the purpose of withdrawing the bridge latch or opening the bridge.

The bridge lock lever, when normal, shall be arranged to lock all levers used for bridge protection in the proper position to protect the bridge, and also to cut off power from all control wires leading to such functions.

A separate locking arrangement shall be provided for each of the following purposes:
(a) To insure that the bridge is in proper alinement.
(b) To insure that all bridge surfacing devices are in their proper position.
(c) To lockall rails in proper position for train movement.

The purchaser will supply complete information, including detail drawings, of bridge locking apparatus to be controlled by the interlocking machine.

NOTE.—It is recommended as a more desirable method of operation that the rails at the end of the draw and on the shore next to the draw be fixed in position and have the necessary locks, and that lifting rails be not used.

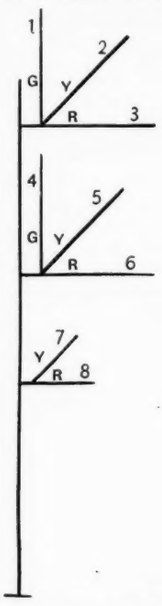
Specifications for Rubber Covered Wire.

These specifications, as adopted by the Signal Association at Washington last October, are recommended in this report for adoption.

Comprehensive System of Uniform Signaling.

The committee recommends the adoption of the report which was adopted at Washington. The essential features of the recommendations of this report are embodied in diagram No. 104, which was shown on page 1196 of the *Railroad Age Gazette*, October 23, last. At the Washington meeting Mr. Stevens (A. T. & S. F.) proposed another code of aspects radically different in some respects from that which had been proposed by the committee, and which had been approved by

1. Proceed at normal speed.
2. Proceed at limited speed.
3. Stop.
4. Prepare to pass next signal at normal speed.
5. Prepare to pass next signal at limited speed.
6. Prepare to stop at next signal.
7. Proceed at low speed.
8. Of no significance, except to mark presence of a low speed signal.



the association, and this alternative code is presented in the present report. The present committee recommends that this be considered before final action is taken on aspects. It is presented in exhibit No. 6, shown on page 352 of the report. Its fundamental principles are shown in the diagram given herewith.

It will be seen that the upper arm and the dwarf arm are

home signals and the second arm is always a distant signal. The upper and lower arms give information leading to the immediate control of a train. The upper arm gives the following indications: 90 deg. position, Normal Speed; 45 deg. position, Limited Speed; 0 deg. or horizontal, Stop. The lower arm is used for slow speed. The second arm gives information leading to the future control of a train. It is a true repeater of the upper arm of the signal in advance. It will be noted in this series of aspects that as the indications become more favorable to the runner, yellow and then green is substituted for red in the order named.

Standard Designs for Specifications for Material.

The committee recommends the adoption of the standard designs and specifications which were adopted by the Railway Signal Association. These are for 1-in. pipe and coupling; gray iron castings; malleable iron castings; machinery steel; wrought iron bars; signal roundels; lenses and glass slides; and for cranks, crankstands, jaws, ladders and about 25 other detail parts of outdoor signal apparatus. The list of these details was given in the *Railroad Age Gazette* of March 5, page 472, in connection with the notice of the March meeting of the Signal Association.

The report is signed by A. H. Rudd, (P. R. R.), Chairman; L. R. Clausen, (C., M. & St. P.), Vice-Chairman; Azel Ames, Jr., (N. Y. C.); C. C. Anthony, (P. R. R.); H. S. Balliet, (N. Y. C.); H. S. Cable, (C., R. I. & P.); C. A. Christofferson, (C. G. W.); G. E. Ellis, (Cons. Engr.); M. H. Hovey, (Cons. Engr.); J. C. Mock, (Det. R. Tun. Co.); F. P. Patenall, (B. & O.); J. A. Peabody, (C. & N. W.); Frank Rhea, (Cons. Engr.); W. B. Scott, (Har. Lines); Thos. S. Stevens, (S. Fe); J. E. Taussig, (Wab.); H. H. Temple, (B. & O.); H. M. Waite, (S. A. L.); Edwin F. Wendt, (P. & L. E.).

Discussion.

Mr. Rudd: There were six subjects specifically assigned to the committee. Subjects 1, 2 and 3 (Specifications for Mechanical Interlocking, Electric Interlocking and Rubber-covered Wire) have all been acted on by letter ballot of the Signaling Association and adopted as specifications. The committee hopes that this association will endorse the action of the Signaling Association. Subject No. 4 (Interlocking Agreement) should be brought up for argument, and No. 5 (Comprehensive System of Uniform Signaling) is a progress report. Some two years ago we adopted mechanical specifications—we never have adopted electrical specifications, we have waited two years for the action of the Signaling Association—and we have never adopted rubber-covered wire specifications. The mechanical specifications submitted are at great variance with the present mechanical specifications of this association. They will probably have to be changed in certain immaterial respects next year, but the specification as it now stands, as completed by the Signaling Association, is so much better than the specifications we have, that I think it should be adopted as a whole.

C. H. Ewing (P. & R.): I would ask the committee when the specifications were adopted by the Railway Signaling Association, and if they have been tried out so as to eliminate the possible defects in a specification which has been recently drawn?

Mr. Rudd: The specifications were submitted to letter ballot last October and adopted. Mechanical interlocking specifications have passed the experimental stage. I do not think there will be any difficulty in carrying out the specifications as at present submitted, because there are, as far as I know, no innovations; it is simply a matter of bringing them up to approved practice.

Mr. Ewing: The committee has excluded the use of wrought iron pipe; they have adopted specifications which permit the use of steel pipe only.

Mr. Rudd: The signal men have been buncoed with wrought iron pipe for the last ten years. The wrought iron pipe we have been receiving has been made of mild steel. If we ordered steel we pay a less price and get better pipe, because some wrought iron pipe is made of a very poor grade of steel.

Mr. Ewing: We should include in these a specification for wrought iron pipe. If we include mild steel, we will get bad steel; if we include wrought iron, we will get better pipe than if we put in steel.

J. C. Mock (Det. Riv. Tun. Co.): The subject was assigned to a sub-committee, and their first draft of a specification calls for steel. We have made a drawing, which is to accompany the material specification, and we have explained to the trade that this drawing will be used for a specification for wrought iron. The specification as submitted to this association, has been changed somewhat from the form in which it was originally written, to raise the tensile strength and limit the elasticity in order to raise it above what could be used for the wrought iron specification, but it is the intention of the sub-committee on Standard Contract to prepare a specification for wrought iron pipe. They thought for the present they would like to have this one tried out, and if we can get pipe in accordance with these specifications it will be all right. After carefully going into the merits of the black and galvanized pipe, the committee decided it would be better to call for galvanized pipe. Of course, that clause can be omitted from the specification by anyone desiring to use black pipe.

Mr. Ewing: I call attention to the committee's recommendation that all pipe posts shall be made of wrought iron.

Mr. Mock: The specifications for the various interlocking installations have been made by various committees, and the commercial term employed is "wrought iron," while, as a matter of fact, it is soft steel, and in these pipe specifications we intentionally change that to steel. The association is trying to harmonize these specifications so we will cut out these little inconsistencies.

Mr. Rudd: The trade name is wrought iron pipe as distinguished from cast iron pipe.

Mr. Ewing: There are reliable manufacturers today who are manufacturing exclusively wrought iron pipe of a very high grade. The only advantage that I have heard mentioned in favor of the steel is its greater tensile strength, elongation. Our experience is that the wrought iron pipe is very much more durable than steel pipe. A steel pipe with a high percentage of manganese begins to pit very soon after it is used and the deterioration is very rapid. Wrought iron does not deteriorate nearly so rapidly. Furthermore, I believe that the wrought iron pipe is a safer pipe to use than steel. Steel pipe, under alternate compression and tension, breaks at the root of the thread. Wrought iron pipe will not; so that I feel it would be a great mistake for this association to pass the specifications for steel pipe only.

On motion by Mr. Ewing the specification for mechanical interlocking was referred back to the committee with instructions to prepare a specification for wrought iron pipe.

The specification on electrical interlocking was received as a progress report.

The specifications for rubber-covered wire were adopted and ordered included in the Manual.

The next subject was Standard Interlocking Agreement for Signal Work.

Frank Rhea (Gen. Elec.): This is a progress report. We felt it was necessary for us to have the association settle, from the standpoint of principle, how the expenses will be divided. It is the desire of the committee that you give us a definite expression on the conclusions that we have presented, or that you give us alternate principles to take their place, in definite form, so that we can then proceed with the conclusion of a final report.

The sample agreement was considered by clauses. Clause 5 provides that the company which constructed the plant shall be in charge of renewals and maintenance, but in the event of its neglect to make certain repairs within 30 days after the second company had notified it of such need, the second company could make repairs and call on the first company to pay its proportion. Mr. Rhea called attention to the fact that this is rather an unusual provision in interlocking agreements as they exist today. There has been a great deal of trouble in one road not properly maintaining interlocking, in not only endangering its own traffic, but endangering traffic of the other interested parties.

L. C. Fritch (I. C.): If there is any question as to the rights of the respective parties it can be submitted to arbitration. It seems to me this clause is covered very well by existing agreements. There is always protection in the use of trackage by the agreements. If the tracks are not in safe condition the second party usually has the right to make such repairs and charge the first party with its proportion of the expense.

Mr. Rhea: Mr. Fritch has made a very good point and the committee merely took advantage of precedent in the line that Mr. Fritch spoke about.

Clause 7 provides that the pay of joint employees be the same as the standards, in the territory concerned, of the company constructing the plant.

Mr. Rhea: That is another provision which has not been general. I have known quite a number of cases where there has been a very fruitful source of misunderstanding as to the salaries. These, of course, are all possible in case of difficulty, to be arbitrated under the arbitration, but it is a good deal better and will eliminate trouble if you have those points explicitly covered.

I would like to call your attention to another paragraph, that bills for expense of the construction shall be made as final bills. I have experienced a good deal of trouble in making partial bills, and I resorted some time past, in cases

where I anticipated having trouble, to making a final bill. The constructing company is allowed a percentage, as a matter of practice, and that percentage, in our opinion, is sufficient to enable them to hold those bills in suspense until they are able to handle it in this way. The party checking the bill is put to much better advantage if he is given a final bill, or is given, in partial bills, a complete statement up to that point.

A. S. Baldwin (I. C.): We have all been troubled by this custom of delaying the payment of a bill on account of probably one or two disputed items, and I have known such delay to be claimed as a cause of breach of contract. I have made it a custom recently to provide that bills should be paid before a certain date, unless there are disputed items, under which circumstances the disputed items are to be withheld and the bill paid on that day.

Mr. Fritch: Mr. Chairman, I want to ask the committee if they have had legal advice on the liability clause?

Mr. Rhea: Yes.

Mr. Fritch: The matter is all there, but the arrangement of it is not, to my mind, as clear as it ought to be. It is usual to divide liability clauses into three parts; first, individual liability; second, joint liability and, third, what you might call the miscellaneous liability. That can be defined, it seems to me in a little better way and divided into three classes. Standard contracts of liability clauses are usually divided in that way, and I would like to suggest to the committee that they see if they cannot further modify or change the wording so as to make it a little clearer.

Mr. Rhea: We will undertake it.

(The secretary then read clauses 13 and 14.)

Mr. Fritch suggested that in many cases a single arbitrator might serve as well as the three provided for in the sample agreement.

J. B. Berry (C., R. I. & P.) suggested that there ought to have been something in the agreement that would stipulate how freight charges should be paid.

Mr. Baldwin: I think there should be some provision that would protect one company against excessive charges on the part of the other, whether for freight, carriage or handling, or anything else, and I would suggest a clause providing that the connecting line should have the privilege of furnishing material if it should desire to do so, or that the prices be made on such a basis as that either company could deliver the material.

On motion by Mr. Fritch, the report on the agreement was accepted as a progress report, and the committee was instructed to confer with the Committee on Uniform Rules in the matter of drafting a completed contract.

The conclusions were then taken up in order. The secretary read conclusion 1.

W. H. Elliott (N. Y. C.): I ask Mr. Rhea under what head he would divide the matter of supplies; would it not be well to insert "supplies" after "maintenance?"

Mr. Rhea: I think the committee would be willing to make an amendment that the road would give due consideration to all expenses involved in the crossing. Our purpose is not to abrogate existing agreements, but that existing agreements shall continue in force and a company that has the advantage of an existing agreement will continue to have it under the changed conditions. That is the purpose and intent of this conclusion.

The conclusion was adopted.

Mr. Baldwin: I call attention to the fact that conclusion No. 2 might be construed by the courts to apply to crossings about to be constructed and I think it would be well to insert, "that with existing crossings, where no previous agreements are in force, the proper division of construction, renewal and maintenance expenses is on an operated-unit basis, etc."

Mr. Rhea: The committee is willing to accept the amendment for the reason we do not believe any recommendation that we make will very largely influence the negotiators in coming situations from giving up the advantage of their tactical position.

Mr. Fritch: I suggest that there be inserted these words: That, in the absence of existing agreements to the contrary, the proper division of construction, renewal and maintenance expenses is on an operated-unit basis, etc.

Mr. Rhea: That is satisfactory.

Mr. Ewing: It seems we are a little bit at sea in this matter. I do not understand that the committee has covered the matter of crossings at all in this conclusion. Under an operated-unit basis each party pays for what is required to interlock its tracks. The road that has prior rights has no business to interlock its own tracks for the construction of another railway.

Mr. Rhea: The intention of conclusion 1 is to protect you now and in the future.

Mr. Rhea moved the adoption of conclusion 2 in this form: "That the proper division of construction, renewal and maintenance expenses is on an operated-unit basis, each party paying for what is required to interlock its tracks, or the residue," eliminating "where there are existing agreements requiring fixed arbitraries," in the last two lines.

Mr. Baldwin: I wish the words, "with existing crossings" in there. I do not want it to be so open.

Mr. Rhea: There are other things besides existing crossings. It may be a junction, not necessarily a crossing; there are other things to interlock besides crossings. I think we might want to make it a little broader than that. Would "existing situations" suit you?

Mr. Baldwin: That will cover it.

Mr. Rhea's motion was adopted.

Mr. Ewing: I move the elimination of conclusion 3, and the insertion in conclusion 2 of the words "and operating" after the word "maintenance."

Mr. Fritch: I am opposed to that, for the reason that clause 3 covers one of the difficulties that we have in interlocking contracts. The strong line may have need for additional men in the tower, and that amendment will burden the weak line with that expense which I think is unfair. A contract that is not fair should not be made. It seems to me that it is a protection to the weak line.

Mr. Ewing: If we are forced at any time to put in a junction or a crossing against our will, it would be a distinct hardship to require us to pay one-half the cost of the operation of that crossing or junction, when we are deriving absolutely no benefit from it. If we are deriving benefit from a crossing or junction, according to the agreement we are required to bear our proportion of the maintenance, construction, etc., of that crossing, based on the advantages we get, so that to my mind it is very necessary that we should allow the operating cost to follow in the line of the direct benefit that we get.

Mr. Fritch: I do not believe that this association should lay down principles that cannot be deviated from. Now, any new contract for an interlocking plant at a crossing of another railway, is a matter of negotiation and the old road usually makes the best arrangement it can. Sometimes the law lays down what procedure shall be followed. But in this particular case you may have a case wherein an interlocking tower and operator is required by one of the roads and not by the other, and it seems to me that this clause exactly covers that point and is very essential.

Mr. Rhea: We do not want to take a narrow view on this proposition. Other public characters have rights as well as those of the companies which we are representing. There is a broader principle than the one of immediate policy involved in this division. The other fellow could not cross our track at grade if the laws did not permit him, and the other man has rights to build his railway, as we had when ours was built. The committee think they have taken a position on which this association can with dignity and with equity appear before any railway tribunal in the United States, or any other country. We all have our responsibilities, as is stated in the report, in safeguarding and expediting traffic.

Our reason for dividing operating expenses on a different basis than construction expenses is that the real equity of each situation is that each man pays for what he really gets. We, as a committee, did not believe that the division of operating expenses on an operated-unit basis can be defended as fair from any point of view. Your operated-units for construction, renewal and maintenance are directly affected just as to what you get. That is a matter which you can locate. You can increase or decrease. With operating expenses, you can have mighty little influence in trimming them. You will pay about so much to operate a station whether you have 24 operated-units or 48 operated-units.

The paragraph in the latter part of conclusion 3 I think is eminently fair and I think is something which has provoked probably as much misunderstanding in interlocking situations throughout the country as any other one subject—one road trying to get the best of another, or get something for nothing, in plain English. There have been a great many cases of that kind, and a great many cases where it has succeeded because agreements in some cases were worded purposely to take advantage which was undue.

Mr. Ewing: I entirely agree with what Mr. Rhea has said as to the division of costs on an operated-unit basis. As to a new junction, or new crossing, the new road has got to accept conditions as it finds them. The old road is there, the new one has got to cross the old road, or connect with it. It puts in an interlocking plant. The old road has not received any advantage at all. Now, what right have we got to say that

they should pay one-half the cost of operating that plant? It seems to me that it is not a fair proposition.

Mr. Baldwin: I quite agree with the view expressed by Mr. Ewing. At the same time the conditions are so varied and the interests at stake differ so very materially, that I believe it to be inadvisable for this association to try to lay down a definite, fixed rule, to govern all cases, and, therefore, I believe a motion to refer back this conclusion to the committee should carry.

J. R. Leighty (Mo. P.): This rule will prevent the interlocking of the crossing of a trunk line by a spur line from another trunk line because the owner of the spur would not be willing to pay one-half the operating expenses of the interlocking plant.

Mr. Elliott: I would like to ask Mr. Rhea how he considers it equitable for a railway crossed by another railway to pay 50 per cent of the operating expenses. Why should not the road which desires the crossing pay the entire expenses of operation?

Mr. Rhea: As I stated previously, it is assumed that existing roads will take care of this in negotiations of new contracts and make the best terms they can. We might have worded that conclusion somewhat differently to make our intent a little more explicit. It is more particularly intended to cover existing situations. The newer railway is being built under the right of eminent domain, as the older one was previously built. You have no right to take the position that you alone can do business and that the other man must be burdened, if he is so unfortunate as to come along later, by all these common expenses. I do not think that you can defend that viewpoint from the standpoint of public policy.

Mr. Elliott: I would like to make an amendment to the motion before the house, that conclusion No. 3 be referred back to the committee to be remodeled in accordance with Mr. Rhea's explanation.

I do not agree with Mr. Rhea in that a new road is obtaining facilities for which the existing road had to pay when it first bought its right of way and built its road and that the expenses of operation of the interlocking plant, incident to the crossing of the new road, should be borne as a part of any other expenses, taxes, construction, property rights, and that the initial road should not be compelled to pay it. In Iowa a law was passed that the old road should pay not only one-third of maintenance expenses, but one-third of cost of construction, and the roads had the point brought before the courts and it was decided that the initial road would have to pay the entire expense of construction, but I believe it is still the law that one-third of the operating expense is paid by the original road.

M. L. Byers (Mo. P.): I would offer this amendment as a compromise between the different views:

That the first sentence of paragraph 3 be omitted.

That the second sentence read: "Where operating expenses are increased beyond the primary operating expenses by facilities for the exclusive use of one party, such party for whose benefit such facilities are provided should pay the entire additional operating expense."

In other words, we do not pass on this point on which we do not seem to be able to agree.

W. C. Cushing (Penna.): It seems to me that we can end this discussion if the committee will say that these conclusions refer only to class A agreements—that is the way I read the report anyhow. I do not think this has anything to do with classes B and C at all, and that being the case, the arguments that have been brought up are entirely foreign to the purpose. If committee says this refers only to class A, I do not think there is anything more to say.

Mr. Rhea: Classes A and B probably.

John V. Hanna (K. C. Ter.): Will the committee explain what is meant by "primary" expenses?

Mr. Rhea: We meant simply the ordinary expenses incurred in operating the ordinary interlocking plant. If you add a lot of block instruments and other expensive apparatus, which require higher salaried men to operate them and more supplies, it seemed to us that it is thoroughly clear that the company getting the benefit of that should pay above what we have termed the primary expense.

Mr. Ewing's motion to refer clause 3 back to the committee for further consideration, and insert the words "and operating" immediately after the word "maintenance" in the second line of conclusion 2 was put to vote and lost.

Mr. Rhea: I move the adoption of section 3 as it stands, with the understanding that it particularly applies to existing situations. This is for the information of the committee and that is the point we would like to have information on, as to existing situations.

G. A. Mountain (Can. Ry. Com.): In seconding that, I would go further and say not only present conditions, but future conditions. Where the junior road crosses the single track of a senior road, and that road afterwards puts four tracks down and adds additional appliances, it does not seem to me fair or equitable that the junior road should be saddled with it.

C. S. Churchill (N. & W.): I trust that clause will not be adopted as it will do injustice to many roads. It conflicts with state laws in many states, and there are cases where traffic must be taken into account. If we insist that the small road shall pay one-half the expense of the interlocking plant, then we might as well give up the idea of having any interlocking plant at that crossing.

The morning session then adjourned.

The afternoon session began at 2 o'clock.

E. F. Wendt (P. & L. E.): I move to amend the motion by striking out all words after the word "moved," and substituting the following: that conclusion 3 be referred back to the committee for revision in the light of the discussion of today.

Mr. Rhea: As a member of that committee I must say that I will be left a good deal in the dark as to what the conclusions are. I do not see how, as a committee, we will be able to make any progress. We will simply have to come back next year to have it settled.

Mr. Rudd: I hope that motion will not prevail. It is simply referring back to the committee, saying "You made this report this year, take it back and guess again next year." Give the committee a chance to know how you feel about it.

Mr. Wendt: The strong reason for referring this conclusion back is that a convention is not the best body to endeavor to rewrite a conclusion. The committee itself should revise a conclusion, and the discussion of this morning indicates that there is no general agreement with respect to this question.

C. P. Howard (L. S. & M. S.): It seems that this association would be going rather far to attempt to pass on the question of the adjusting of the cost of constructing or operating any crossing plant. Suppose, for example, that the cost of maintaining and operating the interlocking plant is borne equally by the two railways. If the total cost of operating and maintaining the plant is capitalized at $100,000, the share of the new railroad would be $50,000. If they could prove to themselves that the cost of overhead crossings would be $60,000, of course as far as they are concerned they would be justified in putting in an interlocking plant. It seems to me that is no part of engineering for us to pass on the proportion of expenses and the equity and justice in this matter; that it is a question of public policy and that all that this association could do would be to indicate the basis on which the cost of the interlocking plant could be figured; say, take the operating unit, and that the cost should be calculated on the basis of an operating unit, but it is no part of our business to indicate how much of this cost should be borne by one company and how much should be borne by another company. I think we should keep clear of that.

Mr. Rudd: If the last speaker's assumptions are correct, this committee is woefully wrong in its position. We have assumed, in canvassing the laws and decisions of the various railroad commissions of the country, that there is actually need of an expert opinion on this subject. I have been called before the railway commissions of some half dozen states; the railway commissions are looking for expert advice on the subject as to what is a proper division of this expense. If we are not as an association capable of passing upon what is a proper technical and equitable division of construction, maintenance, renewal and operating expenses, I am rather at a loss to know what association or what class of experts could determine such a question.

Mr. Howard: I think then, that being the case, that this association should go rather slowly in expressing an opinion on that subject. I think it would be certainly wise to leave this subject in the hands of the committee for further consideration.

Mr. Rudd: I think this is a subject which should be handled with great conservatism, but I feel a somewhat narrow view has been taken of this proposition.

W. G. Besler (C. of N. J.) then addressed the convention, but his remarks were not reported.

The motion to refer conclusion 3 back to the committee was carried.

On motion by Mr. Rudd, it was decided that the present specifications for mechanical interlocking be omitted from the Manual to be printed this year, with a note stating that the subject of mechanical specifications is still under consideration.

Mr. Rudd then moved that the report on subject No. 5, Comprehensive System of Uniform Signaling Suitable for General Adoption, be adopted as a progress report.

B. H. Mann (Mo. Pac.): Where the primary aspects have been adopted, does it mean that the secondary aspects are still open for discussion, or does it mean that both the primary and secondary aspects are still open?

Mr. Rudd: As I understand it, the acceptance of the report as a progress report would not commit the association in any way. That is how I intended the motion.

The motion was carried.

The report on subject No. 6, relating to switchstands, was accepted as a progress report.

Mr. Rudd: In regard to subject No. 7, the revision of the Manual, under general instructions, the only change in the Manual will be the printing of specifications for inside wiring, the mechanical specifications having been eliminated, and the power interlocking specifications having been accepted only as a progress report. I move the adoption of the report.

Motion carried.

The report on subject No. 8, Symbols, was adopted as a progress report.

On motion by Mr. Fritch, the thanks of the convention were extended to the committee for its excellent work.

INJURY TO SIGNAL EQUIPMENT, BRIDGES AND TRACK DUE TO BRINE DRIPPINGS FROM REFRIGERATOR CARS.

Before attempting a conference with the Master Car Builders' Association this committee directed its work toward collecting statistics on the extra cost to the maintenance of way departments of railways handling refrigerator commodities, resulting from the present practice of allowing brine from refrigerator cars to drip on or just outside the rails. That this practice is a factor in the maintenance of way costs is a fact already established, although the special committee has not had sufficient time to gather data from which a correct estimate of the aggregate annual expense to all the railroads due to brine drippings could be deduced. Enough has been learned to demonstrate that the question is one of the most important before the association. The expense due to the shortened life of rails and fastenings, bridges and signal equipment, and the attendant expense because of more frequent inspections required and delays to trains on account of signal failures is difficult to express accurately, and any figures must therefore be regarded as approximate only.

As early as 1897 the Master Car Builders' Association received a report on this subject. The report states that the question was first brought to public attention in 1896.

The following is an extract from a report to the Association of Railway Superintendents of Bridges and Buildings in 1898: "One refrigerator car will produce probably 200 gals. of brine every 24 hours, which is distributed over the roadbed and bridges as the car passes along or is held on a siding. The damage is greatest when the cars are not in motion, and on curves where slow speed is maintained. In order to protect bridges in such places it would be necessary to completely cover their decks with a waterproof protection with gutters to carry off the brine. This is necessary because the vents in the present refrigerator cars vary in their positions, thereby making it impossible to construct a single gutter to catch the flow. It has been suggested that attachments be made to all cars in such a manner that the flow of brine will always fall in the center between the rails. This will furnish considerable relief and in places where the flow is excessive, provision could be made to catch this flow and conduct it away from the metal work."

Previous to this, it was well known to signal engineers and those having to do with the maintenance and operation of automatic signals that the drippings from refrigerator cars very seriously affected the operation of signals in wet weather (the heavy summer showers gave certain relief because of the tendency to flush the rail and rail fastenings). In 1901 the subject was mentioned in the Railway Signal Association in connection with a discussion on the maintenance of track circuits. The Michigan Central was at that time experiencing so much trouble because of brine drippings that on certain troublesome sections they resorted to the use of oil on the rails. While this eliminated the signal failures, it was not a satisfactory solution of the problem from a financial standpoint, as the cost of oiling one mile of track per annum was in the neighborhood of $100.

In 1907, at the seventeenth convention of the Superintendents of Bridges and Buildings, the subject was again discussed; and Past-President Johnston, at the ninth annual convention of this association, also called attention to this subject.

The subject was discussed by the General Managers' Association of the Southeast at a meeting held at Atlanta, Ga., on January 16, 1908. The general experience of the members seemed to be that the volume of traffic with brine drip in that territory was so small that the trouble did not constitute a grave problem.

The foregoing shows that the subject has received no continuous or enthusiastic study by any railroad organization with a view of learning just what it costs, and with the exception of the Master Car Builders' report of 1907, no recommendations have been made that would really do much in the way of improving conditions. It appears that the only method that would effectually eliminate the trouble met with so much opposition on the part of the car owners that the Master Car Builders abandoned it without making a recommendation.

Mr. W. C. Cushing's article in the *Railroad Age Gazette* of June 5, 1908, contained some illustrations of the rapid deterioration of spikes and tie plates which is believed to be due largely to brine drippings. We show herewith a few illustrations of tie plates, rail joints, splice bars and a bridge member, none of which have been in service over five years and some less than two years. We have also obtained data from several railroads giving quite careful estimates on the extra cost to the maintenance of way departments, due to brine drippings.

CHICAGO, BURLINGTON & QUINCY.

Bridges.—On lines not exposed to refrigerator traffic, the paint on bridges will last on the average four years and remain in good condition. On lines which are exposed to refrigerator traffic, the iron work on the stringers and floor beams of bridges begins to show "pitting" when protected only by oil paint within a few months after being painted. The cost of cleaning and painting a floor system will average not less than 25 cents per linear foot of bridge. It has been found that certain paints will last about one year, so that the cost on account of brine is estimated at 25 cents per foot per year. There are 150,000 ft. of iron bridge exposed to refrigerator traffic on the system, so that the annual cost of brine drippings on bridges only amounts to $37,500, which is interest on $750,000.

Track.—The deterioration of the plates, angle bars and the rail itself on tracks exposed is, in a great many places, extremely marked. Angle bars have been reduced ⅛ in. at the edge of the lower angle, and tie plates reduced so that nothing was left but the ribs, which were pressed into the wood. This represents a deterioration during less than ten years, the original thickness of the plates being ⅜ in.

MICHIGAN CENTRAL.

Track.—On 545 miles of eastbound track it is estimated that the loss to rails during their life is about 10 per cent., and the effect on bolts, spikes and tie plates, which require more frequent renewals than the same items on westbound track, which is not affected by the brine drippings, is 50 per cent. On this basis we have the following figures chargeable to brine drippings:

Bolts	$ 9,800
Tie plates	27,000
Spikes	8,000
Rails	12,700
Angle bars	1,500
Labor	50,000

Bridges.—The bridge department estimates that the increased cost of painting and more rapid deterioration of bridges amounts to $25,000 per year.

To this is added $4,000 per year because of increased number of track sections, increased amount of battery and the cost of extra maintenance because of these increases, making a total yearly cost of $145,000, which is the interest on $2,900,000.

Signals.—The signal department report details additional cost as follows:

Maintenance of 91 track sections of the eastbound track above the number of sections used on the westbound track	$ 455
1,000 cells of battery	1,700
Extra labor and attendance	100
Labor and material for more frequent bonding and adding third wire	1,000
Extra amount of labor and material for interlocking fittings, connections, cross pipes, etc.	350
Labor of cleaning tracks	395
Total	$4,000

LAKE SHORE AND MICHIGAN SOUTHERN.

The additional cost on account of brine drippings from refrigerator cars on track circuits is as follows: Toledo district, $301; Michigan district, $100; Eastern district, $85, making a total for added battery of $486. To this should be added the cost of additional maintenance. It has also been found that the fiber in insulated joints on the eastbound track requires renewal oftener than the westbound and the estimated cost on this account is $1,500 per year.

The few statements above quoted are representative of existing conditions wherever refrigerator traffic is handled, and indicate only a portion of the enormous total expense incurred by railroads handling this class of traffic in repairing

damage to signal equipment, bridges and track due to brine drippings. In addition to the maintenance of way departments directly affected, there are a number of other items not easily obtainable because somewhat indeterminate; for example, (a) the additional cost for repairs and maintenance of rolling stock; (b) the cost of trains stopped at automatic signals that have failed to operate due to brine drippings; (c) the extra cost for the upkeep of interlocking apparatus, both mechanical and electrical; and the failures and consequent train delays on account of the reduction of the insulating resistances; (d) electrified sections of railroads, using third rail to furnish the current for traction, will find that drippings from refrigerator cars as now arranged will fall on the third rail. This will of course cause rapid deterioration of the rail and rail supports; it will reduce the insulation resistance between third rail and ground, and consequently add to the power station output, add to any electrolytic action that causes damage, and reduce the factor of safety provided for against accidents to persons working about the third rail.

Conclusion.

Your special committee is of the opinion that the damage to railroad equipment, and especially to maintenance of way equipment, and the failures of signaling and interlocking apparatus caused by the present practice of allowing brine to drip from refrigerator cars en route are of such vital importance in operating costs as to call for immediate action on the part of this association, and we recommend that this association formally request the American Railway Association to take such action as will stop the dripping of brine.

The report is signed by J. C. Mock, (M. C.), (representing Committee on Signaling and Interlocking), Chairman; C. H. Cartlidge, (C., B. & Q.), (representing Committee on Iron and Steel Structures), and C. B. Hoyt, (N. Y., C. & St. L.), (representing Committee on Track).

Discussion.

Mr. Mock abstracted the report of the committee and read the conclusions of the report. He further said: The effect of brine drippings on signal apparatus has not been brought out as fully as we hope to in some future reports if it is found necessary to pursue the subject, although there is given here something of what it means to the signaling department of continuing the practice of permitting the brine to drop from the cars as at present.

L. C. Fritch (I. C.): I offer, in lieu of the conclusion of the committee the following resolution:

Resolved, that the subject of brine drippings be referred to the American Railway Association with the recommendation that immediate action be taken to require that brine drippings shall be deposited in the center of the track in order to minimize the damage caused to maintenance of way structures by reason of the present method of disposing of such drippings.

Louis Shaw (Civ. Eng.): I second the motion, but at the same time state that in my judgment carrying the drippings to the center of the track will not obviate the trouble. On all bridges, the brine will be thrown toward the bottom flanges, which will suffer severely. Any appliances that are placed between the track will also be injured. Some effective remedy to do away with the dripping entirely should be discovered. The maintenance department will be put to expense to make provision to catch the brine in the center of the track. It seems to me the remedy lies in something else. If you cannot take care of the brine the whole length of the road, you can probably take care of the bridge. I think the resolution should first start at the root of the disease. I think any member of the association connected with eastern roads can state what the effect is. I know that the chairman himself has had plenty of experience on this score. I should prefer to see a more definite remedy suggested, something to take care of the brine in the car.

G. J. Ray (D. L. & W.): I agree with what Mr. Shaw says, that we should not take any half-way steps in this proposition. It is certainly a very serious thing with some of the eastern roads—it certainly is in our case. I am in favor of taking some positive action, rather than a half-way remedy, for it is only a half-way remedy if you put the brine in the center of the track. I think we should take some action to prevent the dripping of the brine from the cars at all. In the case of signaling work, and also in the case of the rail, bolts, splice bars and bridge structures, it is a serious proposition and an expensive matter, and becomes more expensive as we increase our battery appliances in railroad work. As we become better equipped with signal appliances this damage and trouble we are now experiencing will grow larger and larger, and it is a matter that should be referred to the American Railway Association with a request to take positive action.

W. G. Besler (C. of N. J.): The subject is one of wider influence than its relation to this association, in that the cars and equipment are much affected by the salt brine drippings, as well as the track appliances, and I have recently had correspondence with the chairman of the South Eastern General Managers' Association, and the Chicago association, all on the subject of this damage, not only to the track, but equipment itself, because of brine drippings. I believe that the action proposed by the committee to refer this matter to the executive committee of the American Railway Association and let that association take care of the matter by delegating it to some sub-committee or some proper committee is the proper action. This subject not only relates to the track but to the cars themselves.

The Vice-President: I ask Mr. Besler, as a representative of the American Railway Association, if he thinks the statistics gathered by our committee would be of interest to the American Railway Association?

Mr. Besler: Any committee assigned to cover this matter by the American Railway Association might use the data we have collected and also the data collected by the M. C. B. Association, and other sources on the subject, all of which would go into any action they might conclude to take. It might be possible they would refer back to us for additional action, or otherwise.

A. W. Johnston (N. Y. C. & St. L.): I heartily second what Mr. Besler says. While the motion offered by Mr. Fritch tends to relieve one particular feature of the trouble, it by no means removes the difficulty. The old type of car had a pipe toward the center of the track, and that was the beginning of the deterioration with which we now have trouble. It seems to me the resolution offered by Mr. Fritch should not prevail, but that the committee's conclusion be the basis of a reference of the whole question to the American Railway Association, to deal with as they see fit.

Mr. Fritch: This matter has been under consideration for ten years. The M. C. B. Association has already recommended to the American Railway Association that this subject be considered. I was fully aware that this resolution did not contemplate the full removal of the evil, but on my opinion it will remove at least 75 per cent. Is it not better to get 75 per cent of the loaf rather than to get no loaf at all? We all know dripping brine in the center of the track will affect bridges, but it will not affect track appliances except where there is a crossing or turnout. It will also not affect the wheels of cars. It seems to me, therefore, a practicable move which can be applied at cost not to exceed $5 a car, and which is more within our possibility of reaching than to open the subject again for some method that will cure the entire evil. I am satisfied if this matter is referred to the American Railway Association it will result very much as it did before.

C. H. Ewing (P. & R.): I believe we would be in better form, in going to the American Railway Assocaition, if we did not tell that association how to cure this trouble. Through their committee they will thresh out the thing for themselves.

J. C. Mock (Det. River Tunnel): I think I speak for the committee when I say I think the remarks of Mr. Ewing are in line with what the committee thought proper to do—not to recommend ways and means, because that is not in their province. The cure will have to be effected on another department of the railway, that is, the motive power. We also felt that we should not recommend a half-way measure. The dripping of brine in the center of the track will but little relieve the signal situation, because the leakage is dependent upon the insulation resistance between the rails for the operation of circuit, and on curves and superelevated portions of track we get it spread a good deal over the area between the rails. In many of our track circuits where we should operate 3,000 or 4,000 feet, we have to cut them down to 1,000 feet. We feel as a committee that we should appeal to you on the question of cost. I have no doubt the bridge department, as well as the signal department, might take care of the situation by spending enough money, but we feel as a committee that we should refer this without mentioning how it should be done.

C. P. Howard (L. S. & M. S.): I would suggest that the matter be referred back to the committee to make a report of the annual expense of this brine dripping, and then present the matter to the American Railway Association; or that this resolution be presented to the American Railway Association now, with the information that certain other data would be presented to them later to give them an approximate idea of the damage caused.

Mr. Shaw: I think the plan outlined by Mr. Besler is the best course. The American Railway Association will appoint a committee with sufficient members to investigate this mat-

ter for themselves, going on the various roads affected and getting figures in which they will probably take more interest than in those you might furnish. I think now is the time for action. I think the proper way would be to let Mr. Fritch modify his resolution, or to vote that down and adopt the committee's recommendation and transmit it with the resolution that the association recommends immediate action.

Mr. Fritch's resolution was lost.

The motion on the conclusion of the committee was adopted.

YARDS AND TERMINALS.

The work of the committee was concentrated mainly upon two subjects: (1) The operation of hump yards; (2) the use of machinery for handling freight.

The Operation of Hump Yards.

The committee presented valuable information as to the details of methods of operation employed at a number of freight yards of the gravity type. There is little opportunity, however, for generalizing or drawing conclusions, owing to the varying local conditions. The matter is therefore given in appendices in convenient form for the information of those engaged in the design or operation of freight yards. (Appendices A and B.) Two separate inquiries were made by the committee: (1) As to the method of operating hump yards; (2) as to the number of yards of this type in use or contemplated. From the replies to the latter series a table was compiled showing 82 such yards in use. (Appendix C.)

There was a preponderance of opinion in favor of placing track scales on the hump. The location varies from 30 ft. to 300 ft. below the summit.

Some advantages of using two scales are also pointed out. They enable separate parallel tracks to be built for summer and winter conditions, and also allow the regular work to continue while one of the scales is under repair. But two parallel humps cannot be used at one time in connection with one classification yard, and to provide an additional or alternate hump for use in emergencies entails a loss of room and distortions of lines in both. There is, therefore, a reasonable doubt as to the value of such installations. At principal gateways of movement, and at points of origin of large volumes of freight of mixed character, and wide distribution the classification should be made, first, as to fast or slow movement, and, second, as to destination.

The question is presented therefore as to the relative merits of the alternative plan of providing a second classification yard with the second hump to be used for fast freight, thus making it possible to take either hump out of service for a limited time without causing complete stoppage of classification, and making it possible to nearly double the classification with a comparatively small increase in facilities. The second hump might be parallel with or in tandem with the first, according to local conditions.

The relation of the percentage or proportion of cars to be weighed to the location of scales on the hump or elsewhere is not yet determined. We have testimony to the effect that the scale should not be located on the hump unless about 25 per cent of the cars to be handled must be weighed. We also have the opinions of men who are in charge of large hump yards that handle thousands of cars daily, that the scale should be located on the hump regardless of the number or proportion of cars to be weighed. We assume therefore that the greatest economy would be secured by locating the scale on the hump if it is assured that from 5 to 10 per cent of the cars must be weighed.

Probably the most important matter for consideration in connection with the subject of prompt and economical handling of freight is proper classification as to character and destination. Therefore when high-class freight has been properly grouped it should not be mixed again with slow freight at a division terminal or point of divergence, but without mixing with freight of different character, should be classified as to destination only in preparation for further movement.

We do not need to omit scales from humps on account of loss of efficiency caused by their installation, but we do need generally better yard design, steeper grades between the summit of humps and the receiving ends of the classification tracks, and better facilities for the return of car riders.

In hump yards in which the grade approaching the hump is heavy the cost of operation is excessive, because a large amount of power is required to get the cars to the summit. In some cases very large engines are used. In other cases two large engines are coupled, and in many cases trains that were hauled into the yard with one engine are cut in two or more sections to be pushed over the hump.

In some cases the lack of room has caused heavy grades approaching a hump, with consequent increase in cost of operation, and in many places where lack of room has prevented gravity classification, it could be successfully employed if the cars could be handled promptly on approach grades that are too heavy for operation by locomotives. We present, therefore, as a suggestion the plans of works that have been in successful operation for many years in Pennsylvania for operating freight traffic over short routes with inclined planes (by cable) instead of over longer routes with ordinary grades by locomotives. These works are still used extensively, notwithstanding the fact that much time and study have been devoted to the problem of devising cheaper and more satisfactory methods. The operation is generally on double tracks, the cars being hauled up by a wire cable first on one track and then on the other. In some cases empty cars are lowered as a partial counterpoise, thereby making it possible to increase the load to that extent. (A description is given in Appendix D.)

It is thought that where more than one engine is required to push a train over the hump, or where the approach grades are too steep to be operated successfully or economically by locomotives, the question of substituting stationary power is worthy of consideration.

Freight Transfer by Movable Platforms.

We have been unable to obtain any further information on the subject of transferring freight by means of movable platforms, as no installations using this method are known to be in service.

Terminal Freight Houses.

Under this heading plans and brief descriptions of the methods used in handling freight are given of the Grant street freight station (Pittsburgh) of the Pennsylvania Lines; Wabash-Pittsburgh Terminal Ry.; Missouri Pacific, at Kansas City; Pennsylvania Lines, at Columbus, Ohio, and Indianapolis, Ind.

With reference to the general arrangement of buildings and platforms and the track layout of freight terminals, Mr. Rockwell, Chief Engineer of the Lake Shore & Michigan Southern, submitted plans of the recent freight layout on the Middle Ground at Toledo. The result obtained with this layout is about as follows: In the old house, which this supersedes, 29 gangs of six men each handled 200 cars in 24 hours at a cost of about 45 cents per ton. In the present houses, the same amount of work is done with 17 gangs of six men each at a cost of about 35 cents per ton. It is estimated that when business increases sufficiently so that there will need to be handled 400 cars in 24 hours, it can readily be done with 30 gangs at a cost of not to exceed 30 cents per ton.

Particulars of a large modern freight terminal station on a British railway, with a large equipment of freight handling cranes, are given in Appendix E.

Freight Handling and Conveying Machinery.

Your committee's inquiries in this direction have been mainly barren of practical results, and there appear to be no conveyors in use in ordinary freight houses.

For handling heavy or bulky freight at yards, cranes are very generally used. These may be fixed jib cranes, or overhead cranes of different classes.

For handling freight in a warehouse, pier shed or freight house, the following systems may be used: (1) Conveyors (roller, chain, belt, platform, etc.); (2) overhead traveling cranes; (3) carrier systems. Freight handling in railway storage warehouses was described in our 1908 report, and particulars of the extensive crane equipment in a British railway freight warehouse are given in Appendix E.

Freight handling by machinery may be divided into two classes: (1) In warehouses and steamship piers, where the movement is mainly longitudinal. (2) In freight houses, where there are numerous movements in different directions. The former case is much the simpler, but it may be found practicable to introduce mechanical handling, so as to reduce the amount of trucking in the latter case.

Cranes are used in some warehouses, but as a rule the height of the ordinary freight house is not sufficient to permit the use of an overhead traveling crane. A railway warehouse in Scotland has revolving cranes (with horizontal booms) suspended from runways. These give greater flexibility and capacity than an overhead traveling crane with hoisting trolley.

Traveling hoist installations have been planned. One manufacturer states that he has figured on several such installations, but that with enough trackage to cover the floors satis-

factorily the cost is so high that the proposition is usually dropped.

The general opinion seems to be that there is no machinery or conveyor equipment that can successfully handle freight in ordinary freight houses, and that it would be difficult to devise a satisfactory equipment for such service. The special difficulties are: (1) The great variety in shape, size and weight of the packages; (2) the fact that packages delivered by teams at the various doors have to be distributed to cars at various points on the other side of the house. Ordinary conveyors are not adapted to this service, being more suitable for carrying packages between fixed points of receipt and delivery.

Two possible methods of handling freight between variable points are movable platforms for the packages, or means of moving the trucks by mechancial power so as to reduce the time and labor involved in moving them by hand over long distances. A traveling platform level with the floor has been devised, moving at slow speed, so that men, trucks and teams can cross it. As proposed for an inbound freight house of the Baltimore & Ohio, the moving platform would form a belt line; one side would be near the track side and the other near the team delivery side. Packages (or trucks) from the cars would be dropped on the moving platform. The house would be divided into sections, with a man to each, and each man would pull off of the platform the freight for his section as it passed him. In another system, the platform would be a single line only, the return side being underground. This was designed more particularly for steamship piers, where freight delivered at the end or from a ship has to be transferred for a considerable part of the length of the pier.

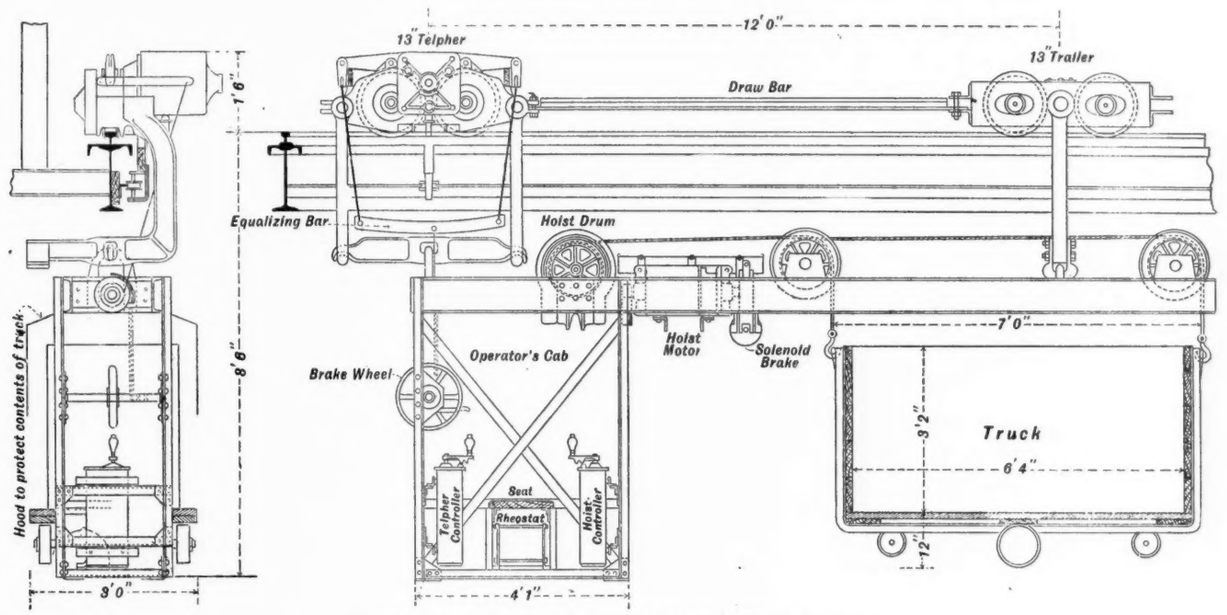
For handling the trucks, the committee presents information as to two systems: (1) An overhead runway system; (2) an underground cable system.

(1) The first is described as it is in use at a steamship pier, and is to be used by the Baltimore & Ohio Railroad. It is the Dodge system. A pair of trolleys riding on an elevated runway carry a frame with hoists for raising and lowering trucks or wheeled platforms. Current for electric traction is taken from an overhead wire, and an attendant riding with the machine controls the traveling and hoisting movements. This system has been in operation for about four years on the pier of the Old Dominion Steamship Co., at Richmond, Va. It handles 3-ton loads between the wharf and the railway warehouse and cars. It is said to show a great saving in cost over the old hand-truck method, besides being able to handle freight more rapidly and with much greater ease.

A telpherage installation has been designed for the Bergen (N. J.) freight house of the Erie Railroad. This house has three platforms, each 1,400 ft. long, and three telpher tracks (one over the center of each platform) connected by loops at the ends. Ten telpher machines operating at one time on the three tracks, all machines following each other in the same direction around the loop, would provide for a movement of 1,000 tons of freight per day of 20 hours. Each machine is required to make one round trip of 3,000 ft. in six minutes (at the rate of 10 trips per hour). The average speed would therefore be 500 ft. per minute, including all stops and slowdowns, and the maximum speed of traveling will be 1,500 ft. per minute.

The cost of handling freight in the above manner has been figured at 5 cents per ton. This is based on carrying an average load of only 1,000 lbs. at each trip, although the machines are to have a maximum capacity of 2,000 lbs., which seems sufficient to handle the bulk of the freight. This cost per ton is also based on electric power supplied at 4 cents per k. w. hour, and a telpher rider at 20 cents per hour. This does not include the labor for loading the freight onto the trucks and placing them beneath the telpher runway, nor for unloading the trucks and replacing them under the runway. These figures are from the manufacturers of this system.

The Memphis Warehouse Co. has overhead trolley tracks (Breck system) for handling cotton. The trolleys are not motor-driven, but the tracks have a slight grade so that the load moves by gravity. The grade begins at the beginning of the inbound platform and extends through the plant to the end of the outbound platform, a distance of about 1¼ miles. The arrangement permits of placing four (or even six) trains of 25 cars each at the inbound platforms at one time, without "spotting." This makes it possible for one switching engine and crew to do the work, while ordinarily three or four engines would be required. There are about three miles of the trolley runway and six miles of railway tracks. The cost of handling by the telpherage system is said to be only about one-eighth of the cost of teaming. The company has an extensive cotton warehouse and compress plant, with storage capacity under cover for about 125,000 bales.



Carrier for Telepherage Freight Handling System.
(Bergen Freight House of Erie R. R.)

(2) A system of handling freight trucks by a traveling chain, has been patented by a firm of conveyor manufacturers, and is intended to reduce the labor of the trucking in a longitudinal direction. The idea was to devise a system that would provide for taking freight from any car along the platform and deliver it to any other car, as conditions require. In order to accomplish this, it was found desirable to use the ordinary hand-truck, with slight modifications, so that it can readily be wheeled around from one place to another by manual labor when desired. The truck travels upon a narrow-gage track, and is provided with special attachments to engage an endless chain set underneath the track. This driving chain lies entirely beneath the floor, and

is out of the way. As there is only a groove 1 in. wide in the floor, there is no danger of accidents, and the floor is left entirely clear to truck across or walk upon at any time.

Another method proposed is a slow-moving platform, flush with the floor. It is intended more particularly for piers and transfer stations.

Appendices.

As indicated in the foregoing, there are five appendices to the report. Appendix A gives details of operations of hump yards of the Baltimore & Ohio; Canadian Pacific; Chicago & Eastern Illinois; Chicago, Burlington & Quincy; Chicago, Indiana & Southern; Delaware & Hudson; Erie; Lake Shore & Michigan Southern; Lehigh Valley; Michigan Central; Missouri Pacific; New York Central; Norfolk & Western; Pennsylvania; Philadelphia & Reading; Pittsburg & Lake Erie; Southern; Terminal Association of St. Louis; Vandalia, and Washington Southern. Information is given on the following points: Maximum number of trains entering receiving yard in one hour; average number of cars per train; average train pushed over hump; average number of cuts per train; number of cars passing over hump that are weighed; whether cars are uncoupled to be weighed; location of scales; whether or not scales should be on hump; number of switching engines in hump service; whether the engine keeps the train moving continuously over the hump; average classifying capacity of hump; time allowed engine crews for meals, cleaning fires, etc.; time hump is actually in operation; number of car riders per hump and method of return; method of determining number of car riders needed; method of operating switches; cost per car for yard handling.

Appendix B is a description of the operation of the Galesburg yard of the Burlington.

Appendix C is a list of the freight yards in America on the hump system.

Appendix D is a description of the inclined planes used in Pennsylvania for handling freight traffic.

Appendix E is a description of the freight handling equipment of the new terminal freight station and warehouse of the North British Ry. at Glasgow, Scotland.

Conclusions.

The committee had no conclusions to present. It recommended that consideration be given to the practicability of applying freight-handling machinery in individual cases.

The report is signed by F. S. Stevens (P. & R.), Chairman; E. E. R. Tratman (Eng. News), Vice-Chairman; Hadley Baldwin (C., C., C. & St. L.), G. H. Burgess (Erie), L. G. Curtis (B. & O.), A. H. Dakin, Jr. (Mil. Term.), H. T. Douglas, Jr. (W. & L. E.), A. C. Everham (Det. Riv. Tun. Co.), A. P. Greensfelder, F. G. Jonah (N. O. Term'l Co.), B. H. Mann (Mo. P.), J. D. Mason, A. Montzheimer (E., J. & E.), G. F. Morse (C. R. R. of N. J.), Samuel Rockwell (L. S. & M. S.), C. S. Sims (D. & H.), C. H. Spencer (Wash. Term'l Co.), C. H. Stein (C. R. R. of N. J.).

Discussion.

Mr. Stevens: We present for your consideration a supplement to our preceding report. We have no additional conclusions to present. Our report of last year treated largely on the construction of hump yards. This year we present some facts bearing on the operation of such yards. The report, as a whole, is a report of information and we ask that it be adopted as submitted.

The report was adopted.

L. C. Fritch (I. C.): I would suggest to the committee that next year they submit to us a typical design for various classes of hump yards, yards where the majority of the cars are empty cars, and yards where heavily loaded cars are in the majority, also typical yards under various climatic conditions. I think that is something we lack.

The President: The secretary suggests that the chairman of the committee indicate some of the paragraphs which should be taken up by the members during the year, in order that the members may be prepared at the next meeting to discuss them in detail.

Mr. Stevens: The matter of transfer stations was reassigned last year, but inasmuch as the convention did not appear to wish to consider the suggestions that were made on points on which there were no installations to which we could refer, I will say the matter is in precisely the same condition it was left in then, because there are still no installations of which we have knowledge to which we could refer for further light on the subject.

The matter of freight handling machinery has been a live question with this committee for several years. We have made numerous investigations, and have had a great deal of correspondence with people who have manufactured appliances of this kind and those who thought it desirable to install them, but have not yet found anyone who has been able to recommend a telpherage system or transfer system of any kind as applicable to the transfer of miscellaneous freight.

RAIL.

The Board of Direction instructed the committee as follows:

(1) Continue the investigation of the breakage and failure of rails and present summary of conclusions drawn from reports received.

(2) Report on the results obtained from the use of open-hearth steel rails and the chemical composition of such rails.

(3) Report on any recommended changes in specifications for Bessemer steel rails as heretofore adopted by this association.

(4) Present recommendations as to standard rail sections.

(5) Present report showing diagrams or photographs of typical characteristic rail failures corresponding to the classification as given in old form M.W. 1200 (new form M.W. 2002-A), "Report of Rail Failures in Main Tracks."

(6) Joints considered as a whole. Recommended design and specifications.

The committee of the American Railway Association on Standard Rail and Wheel Sections in its report of March 23, 1908, recommended the following, which was adopted at the meeting held in New York, April 22, 1908:

"Your committee respectfully recomends that the series of sections of types 'A' and 'B,' and the specifications for Bessemer and open-hearth steel rails, submitted with this report, be adopted as the recommended practice of the association, and that the sections and specifications be referred to the American Railway Engineering and Maintenance of Way Association, with the request that they follow up the question of determining the details as to drop test, etc., by observing the actual results of rails rolled under the new sections, and that they also arrange to collect from the different members and tabulate all information as to comparative wear of rails rolled from the different parts of the ingot, and all other information necessary to a proper study of the problem. That they be further requested to keep careful record of the comparative results in service of rails of types 'A' and 'B,' and to prepare and submit to this association a single type of section which will embody their ideas as to the best type that can be designed for use as a single standard to be adopted by this association, giving due weight to every factor entering into the problem."

This action was conveyed to your committee and was considered as a part of its instructions.

Your committee, fully recognizing the great importance of the work assigned to it, thought it wise to proceed with deliberation. At the first meeting of the committee it was decided that on account of the large field to be covered and the size of the committee it would be advisable to subdivide the work, and therefore one of the essential matters for attention was the adoption of a proper organization to carry on the work. (This organization, comprising three sub-committees, was given in the *Railroad Age Gazette*, June 19, 1908, page 175.)

Referring to the instruction in regard to the investigation of rail breakage and failures, your committee has recognized the necessity of securing accurate data in order that proper deductions and conclusions may be drawn, and it considers it necessary that reports of all kinds should be on a uniform basis for reporting on the manufacture of the rail as well as its behavior afterward in the track; therefore we have devoted considerable time to the preparation and consideration of a proper scheme of blanks for reporting rail failures. The blanks recommended were submitted to the association for letter-ballot (see Bulletin No. 102) in order to get them into use as early as possible, without waiting for action at the annual meeting. (These blanks are practically the same as those of the Pennsylvania Railroad given in the *Railroad Age Gazette*, January 1, 1909, page 14.)

Your committee understands that the main part of its work, in this connection, is to study rail failures quantitatively, and the blanks have been drawn up with that end in view. A quantitative tabulation of rail failures, from year to year, ought, ultimately, to give valuable information to the association by serving as an index, by numbers, whether the results obtained from the new patterns of rail rolled under the specifications are coming up to the expectations. The way has already been paved for such information by the classification of rail failures on the back of the track foreman's report blank, M.W. 2002-A, which was adopted by the association at the last annual meeting.

Although the rail committee recommends this series of blanks to the members of the association as suitable for keeping rail service records, it will itself only need three for

receiving the quantitative reports of failures from the members. These three forms, 2004-A, 2004-D and 2005-D, will be supplied and sent out to the members by the committee to be filled out for the six months' period ending October 31, 1908, and similar information will therefore be regularly requested for six months' periods, viz.: April 30 and October 31, this division being intended to give winter and summer periods, in order to study the effect of each.

Your committee feels that the study of individual rails can only be taken up in part, as it is impossible for the committee to consider the individual rail failures on all the railroads in our membership. It is, therefore, assumed that each member of the association will make the study of individual rails for his own system, digest the information as much as possible, and furnish the committee with accurate informtaion which may be of value to all the members and enable them to draw proper conclusions.

The following resolutions were submitted to the association for letter-ballot and were adopted:

"Resolved, That the complete set of rail statistics blanks previously described be used by the members of the association for reporting and compiling information relative to rail failures and rail service.

"Resolved, That form 2004-A, Summary of Steel Rail Failures for Six Months, Compared with the Same Period of Previous Year; form 2004-D, Position in Ingot of Steel Rails Which Failed, and form 2005-D, Record of Comparative Wear of Special Rail, be adopted by the association as approved forms for receiving statistics for the quantitative study of rail failures.

"Resolved, That the members of the association furnish the rail committee with reports of studies of individual rail failures or rail service, from time to time, as soon as such studies have been made.

"Resolved, That these recommendations be accepted and put into effect at once by the members of the association, subject to revision at the annual meeting."

The committee recommended that the blanks be added to the Manual of Recommended Practice. The committee arranged to have forms 2004-A, 2004-D and 2005-D, for report of rail failures for six months ending October 31, 1908, sent to the railroads of the country through the American Railway Association.

The quantitative statistics will show whether rail failures are increasing or decreasing, from year to year, and what particular kinds of failures are the most numerous, but it will be necessary also to have the information to be derived from the study of individual rails in order to determine, as nearly as possible, the cause or causes for the different kinds of failures, so that we may apply our knowledge to the correction of the troubles. The following plan is, therefore, suggested for each official charged with the study of rail failures for use both for his own benefit and for the benefit of the Rail committee:

(1) Four rails of every hundred which have failed in service should be selected for investigation and analysis.

(2) As the track foreman's reports on form M. W. 2002-A come from the division officers, the chief engineer, or chief engineer of maintenance of way, should select four cases out of every hundred which, in his judgment, will furnish valuable information upon being investigated. If he desires he may leave this selection to the division officer, as it may happen that the division officer may have a better opportunity for selecting good samples than his superior. As soon as the selections have been made blank M. W. 2002-A, for the special rail in question, should be checked by an engineer by a visit to the place where the rail was found, and he should also inspect the rail.

(3) The selected rail or piece of it should be sent forward to the laboratory where it is to be examined and a copy of the checked track foreman's report, M. W. 2002-A, should be sent to the laboratory, and the chief engineer or chief engineer of maintenance of way should also retain a checked copy.

(4) At the laboratory there should be made:

(a) Photographs of the defective or broken rails.
(b) A chemical analysis.
(c) A physical test, such as tensile strength, elastic limit, elongation, etc.
(d) Micro-photographs showing the structure of the material.

The chemical and physical results should be reported to the chief engineer or chief engineer of maintenance of way on form M. W. 2003-A, and the photographs and micro-photographs, made on the same size sheet, should be pinned to it. If the place for remarks on the form is not sufficient to explain the results of the examination, further explanation can be given in a letter.

Upon receipt of this report, the chief engineer or chief engineer of maintenance of way can, if desirable, add the chemical analysis originally obtained from the mill, and also the drop test. The complete report would then consist of:

(a) Copy of the track foreman's report on form M. W. 2002-A, after being checked by an engineer.
(b) Results of chemical analysis and physical test on form M. W. 2003-A.
(c) Photographs of the defect or fracture and micro-photographs of the interior structure.
(d) A complete written analysis or deduction from the study of the above information.

The rail committee should receive a copy of such a study or else a report by the chief engineer or chief engineer of maintenance of way, giving the results of a collection of similar studies.

Recommendations.

Your committee offers the following recommendations for approval:

1. That Form M. W. 2003-A, heretofore submitted (see Bulletin 102), be approved as a standard form of the American Railway Engineering and Maintenance of Way Association for receiving reports of the chemical analysis and physical tests of individual rails.

2. That a complete report of the study of an individual rail should consist of:

(a) Copy of the track foreman's report on Form M. W. 2002-A, after being checked by an engineer.
(b) Results of chemical analysis and physical test on Form M. W. 2003-A.
(c) Photographs of the defect or fracture and micro-photographs of the interior structure.
(d) A complete written analysis or deduction from the study of the above information.

We further recommend that blank No. 2003-A be incorporated in the Manual of Recommended Practice.

Drop Testing Machine.

Your committee considers that a uniform system of testing at the mills is essential. The following specifications for a standard drop testing machine were submitted by letter-ballot to this association:

SPECIFICATIONS FOR DROP TESTING MACHINE.

A drop testing machine conforming essentially to the manufacturers' plans and specifications and in general accord with the following requirements will give satisfactory results:

1. The machine shall be arranged to allow a 2,000-lb. tup to fall freely at least 25 ft. on the center of a rail resting on supports that can be adjusted to spans varying from 3 ft. to 4 ft. 6 in.

2. The anvil shall be a solid casting, weighing, with the attachments that move with it, 20,000 lbs. It shall be free to move vertically independently of the lead columns and shall be supported on 20 springs known as the standard "C" spring, without center coil, as employed by the Master Car Builders' Association (their figure 5614). This spring has a free length of 8¼ in., an outside diameter of 5 7-16 in., and is made from a bar having a diameter of 1 3-16 in. These springs are to be arranged in groups of five at each corner of the anvil and are to be held in place by hubs raised on the top of the base plate and by circular pockets on the underside of the anvil. Removable finished steel wearing strips shall be secured to the anvil and the lead supports for guiding the vertical movement of the anvil.

3. The base plate shall be of cast-iron or cast steel 8 in. thick in the area covered by the anvil. It shall be firmly secured to the substructure by four bolts 2 in. in diameter.

4. The substructure shall consist of a timber grillage resting on a masonry foundation. The grillage shall project 9 in. beyond the ends of the base plate, and clear the columns at the side. It shall consist of one course of 12 in. by 12 in. sound oak or southern yellow pine, preferably creosoted, laid close and well bolted together. The masonry, preferably concrete, shall be not less than 5 ft. deep below the grillage and be suitably supported on the subsoil.

5. The pedestals for supporting the test rail shall be substantial castings. The rail supports shall be removable pieces of steel, securely held in the pedestals, having an upper cylindrical bearing surface, with a radius of 5 in. The pedestals shall be adjustable to spans varying from 3 ft. minimum to 4 ft. 6 in. maximum between centers. They shall be securely held together, and so fixed to the anvil as to

insure that the center of span shall always coincide with the center between leads.

6. The leads shall be firmly connected to the base plate and well braced. They shall be long enough to provide the prescribed free fall of the tup. They shall be provided with a convenient ladder and a plainly marked gage, divided into one-foot intervals. The zero of this gage shall be 5¼ in. above the top of the rail supports, and the specified height of drop shall be measured from this zero irrespective of the height of rail being tested. One of the guides shall have a removable section 6 ft. long at the bottom, so that the tup or tripping block can be readily removed.

7. The tup shall weigh, with the accessories that drop with it, 2,000 lbs. The striking die shall be steel, having a cylindrical striking face, with radius of 5 in. and a length of 12 in. The guide grooves shall have finished surfaces. The tripping head shall allow a grip of the tongs that will release at the exact height for which the tripping device is set, and that will be safe from accidental release while the test piece is being shifted.

8. The tongs and tripping device shall be arranged to release the tup automatically only; no manual releasing will be allowed. The tripping device shall be easily adjustable at 1 ft. intervals.

The resolution accompanying the specifications (see Bulletin 102) is as follows:

"Resolved, That a copy of the report of Sub-Committee No. A, on Drop Testing Machine, be sent to the secretary of the American Railway Engineering and Maintenance of Way Association, with request that the matter be presented to the board of direction with request that the same be acted upon promptly and placed before the association in proper form by letter-ballot for approval, after which it is to be referred to the American Railway Association for approval."

The association approved the specifications by letter-ballot.

Use of Open-Hearth Steel Rails and their Chemical Composition.

Referring to the second instruction, we can only report that we have the matter in mind. Owing to the financial conditions existing during the past year, very little rail has been bought by the railroads of the country. The committee will secure statistics in the future for rails of special manufacture wherever possible. During the past year a number of roads purchased open-hearth rail, but sufficient time has not elapsed for the committee to secure the data necessary for a report.

Recommended Changes in Specifications for Bessemer Steel Rails as Heretofore Adopted by the Association.

In view of the fact that the American Railway Association has adopted a specification which has been referred to our association and that we have been asked to observe the action of rails rolled under the new specifications, it will be some time before definite results and recommendations can be given.

Referring to Instruction No. 4, "Present Recommendations as to Standard Rail Sections;" Instruction No. 5, "Present Diagrams or Photographs of Typical Characteristic Rail Failures," and Instruction No. 6, "Joints," we can only report progress on these instructions. We have arranged for a series of tests at the Watertown Arsenal of a number of types of rail joints from which we expect to derive some valuable information.

Canted Rail.

We have been looking into the matter of canted rail and have reports from 190 railways, members of your association. One hundred and seventy-four roads report no experience, 14 roads are trying canted rails with varying success, and one road is in favor of the plan. Three roads get the cant in the tie plates; the others adze the ties. One road has recently issued instructions for tracklaying and proposes to cant all its rail.

Appendix.

We submit as an appendix to this report a discussion on blanks for reporting rail failures, furnished by Mr. John D. Isaacs, a member of the committee, in which he outlines the method followed in reporting and studying failed rails on the Harriman Lines. (This was published in the *Railroad Age Gazette*, November 13, 1908.)

Conclusions.

The following conclusions are submitted for your approval:

(1) That the complete set of rail statistics blanks, previously described and approved by letter-ballot, be used by the members of the association for reporting and compiling information relative to rail failures and rail service.

(2) That Form 2004-A, Summary of Steel Rail Failures for Six Months, Compared with the Same Period of Previous Year; Form 2004-D, Position in Ingot of Steel Rails Which Failed, and Form 2005-D, Record of Comparative Wear of Special Rail, be adopted by the association as approved forms for receiving statistics for the quantitative study of rail failures.

(3) That the members of the association furnish the Rail Committee with reports of studies of individual rail failures or rail service, from time to time, as soon as such studies have been made.

(4) That Form M. W. 2003-A, heretofore submitted, be adopted as a standard form of the association for receiving reports of the chemical analysis and physical tests of individual rails.

(5) That a complete report of the study of an individual rail should consist of—

(a) Copy of the track foreman's report on Form M. W. 2002-A, after being checked by an engineer.

(b) Results of chemical analysis and physical test on Form M. W. 2003-A.

(c) Photographs of the defect or fracture and micro-photographs of the interior structure.

(d) A complete written analysis or deduction from the study of the above information.

(6) That the blanks described above and approved by your association by letter-ballot, also blank 2003-A, be added to the Manual of Recommended Practice.

(7) That the specifications and plan for drop testing machine, herewith submitted to the association for letter-ballot, be adopted as standard.

(8) That the specifications and plan for drop testing machine be added to the Manual of Recommended Practice.

(9) That the specifications for Bessemer steel rail, as presented in the Manual of Recommended Practice, be allowed to remain in the Manual as now printed.

(10) That the following note be added to the specifications in the Manual: "The Committee on Rail has under consideration the matter of revised specifications."

The report is signed by D. D. Carothers (B. & O.), Chairman; R. Montfort (L. & N.), Vice-Chairman; Robert Trimble (Penn. Lines), Secretary; E. B. Ashby (L. V.), J. A. Atwood (P. & L. E.), A. S. Baldwin (I. C.), J. B. Berry (Rock Island), Chas. S. Churchill (N. & W.), W. C. Cushing (Penn. Lines), F. A. Delano (Wabash), Dr. P. H. Dudley (N. Y. C. Lines), C. H. Ewing (P. & R.), J. F. Hinckley (Cons. Engr.), John D. Isaacs (Har. Lines), Thos. H. Johnson (Penn. Lines), Howard G. Kelley (G. T.), J. W. Kendrick (A., T. & S. F.), George W. Kittredge (N. Y. C.), D. W. Lum (Southern), Jos. T. Richards (P. R. R.), and J. P. Snow (B. & M.).

Discussion.

Mr. Churchill: The progress of the work of the committee has been as rapid as possible, considering the difficulties that confronted the committee. These difficulties, briefly, are that no systematic method was being followed by different railroad companies reporting breakage of rail, no uniform method was followed by different railroads in keeping track of rails in the track and the service given by rails. Railroads would report they had a rail in the track so many years. That statement was of no value unless we knew how much traffic the rail had carried. We had no record of what part of the ingot the rail was taken from, we had no record as to what kind of a drop test had been made at the mills. Then the drop test machines themselves at the various mills vary so much in their construction that no accurate results could be secured, so the result of the work has been, first, to adopt a series of forms on which to make reports of the records of rails from the very beginning and a uniform drop testing machine to be used at all mills. The conclusions, many of them, have already been acted upon, but we want a reaffirmation of them in order that they may go in the Manual.

The secretary read the conclusions.

C. E. Lindsay (N. Y. C.): Do I understand that paragraph (a) in conclusion 5 has been adopted?

The President: Yes.

Mr. Lindsay: We have it in use on the New York Central Lines, and in practice we found it would be desirable to have the gage line of the rail indicated in some way, so that the defect in the rail could be referred to in its relation to the gage line. In some cases you cannot tell it is the gage inside of the rail, from the picture or description in the report.

Mr. Churchill: The committee will take note of that and see if it can be introduced later on.

Hunter McDonald (N. C. & St. L.): I wish to refer to paragraph (d) in conclusion 5, as to what constitutes a complete report. As I understand it, the different railroads are asked to transmit to the committee interesting features of cases of rail failure. It is not within the power of a good many railroads to furnish the information that is called for here. For instance, there are quite a number of roads that do not maintain a laboratory for the purpose of making chemical anlyses, nor have they the facilities or money to spare for the purpose of having photographs made of broken rails, etc. Am I to understand that the committee does not want any report except those that are complete as defined in this conclusion?

Mr. Churchill: The committee desires that reports be made as fully as the conclusions specify, but where railroads are not equipped to furnish the report in such detail, they should say so. We want all the available information that can be furnished, and desire to have it as complete as possible to cover all questions that may arise.

Mr. Cushing: Conclusion 5 says that this is a study of an individual rail, and it refers only to the study of the individual rail. If any company has any additional information to give about any particular rail that it has studied, we recommend that it be furnished the committee in that form. It has nothing to do with the filling out of these blanks which were sent around to the various members of the association some time ago for the general information as to the number of different kinds of rail failures. If a rail has failed under peculiar circumstances, because of a wreck possibly, a pretty thorough investigation of that rail is made, and this simply takes care of how the committee would like to have the report made in such case.

Mr. Churchill: On behalf of the committee I move the adoption of the conclusions as read.

The motion was carried.

The President: The chairman of the committee has a statement to make.

Mr. Churchill: Sub-committee A made a number of tests at Sparrow's Point mill, in the presence of the full committee and of the manufacturers' committee, of a number of rails of different sections, including "A" sections and "B" sections of the new form, as well as the American Society section, and that compilation is about completed.

The sub-committee who have charge of testing rail joints as a whole are following that up. It took quite a long time to get from the different railroads samples of joints. They have all gone forward to the Watertown arsenal, and tests on joints are now in progress under the auspices of the Government, overlooked by two committees—the committee representing this association and the committee for the Testing Materials Association.

TRACK.

Sub-committees were appointed as follows:

(A) To revise the frog table submitted in 1908 and to extend the table to make it more nearly universal and to present a definite recommendation for the length of switch for each frog.

(B) To prepare specifications for switch points to be used on Class A track.

(C) To prepare specifications for standard spring frogs for Class A track.

(D) To prepare specifications for switchstands.

(E) To confer with American Railway Master Mechanics' Association on the subject of widening of gage on curves, and to present report on throat clearance and guard rail clearance.

(F) To adapt formulas and tables on spirals for publication in the Manual.

The following outline of work was given by the Board of Direction:

(1) Review and revise the committee's report presented at the ninth annual convention, covering the following subjects:

(a) Report on the subject of turnouts and turnout material, including the best types of switchstands, switchpoints, frogs, guard rails and throat clearance, bearing in mind the possibility of an increase of the thickness of wheel flanges and the effect of worn tires and wheels upon the various parts of turnouts, frogs and crossings.

The committee presents in Appendix A its report on the foregoing subjects.

(b) Report on facing point switches for high speeds with a continuous main line rail.

Your committee reaffirms its report of last year on the subject of facing point switches with main line rail.

(c) Confer with committee on signaling relative to switchstands.

Your committee reports progress on this subject, and requests further time.

(2) Continue investigations in connection with a sub-committee of the American Railway Master Mechanics' Association upon the subject of widening the gage on curves and spacing of guard rails, as affected by the different lengths of engine wheel base, arrangement of flanged wheels and wheel wear.

Your committee has held conferences with joint committees of the American Railway Master Mechanics' and Master Car Builders' Associations during the year and as a result begs to recommend the following resolution:

Resolved, That the clear width of standard flangeway for all frogs and between main rails and guard rails be 1¾ in., measured at the gage line, for all tracks of standard gage.

A drawing shows position of wheels with maximum and standard flanges with reference to 1⅞ in. throatway and for 1¾ in. throatway. The meeting with the Wheel Committee of the Master Car Builders' Association brought out the fact that some changes were necessary in the M. C. B. standard reference gage as used for mounting. The corrected gage is shown on the drawing.

Your committee requests further time in which to prepare its report on widening of gage.

(3) Report on whether wide gage, which is due to worn rail, should be corrected by closing in or replacing the rail.

After careful consideration of the above subject, your committee begs to report as follows:

Wide gage, due to worn rail, within the safe limits of wear, need not be corrected until the excess over the gage is equal to or exceeds ½ in., and should then be corrected by closing in.

(4) Report on the extent rail should be worn before it becomes unsafe.

Your committee is not in position to make a definite recommendation upon the extent rail should be worn before it becomes unsafe.

(5) Consider revision of paragraph (3), under "Proper Method of Spiking," Manual, 1907, p. 64, and report recommendation as to extent gage on curves should be worn open before closing in is necessary.

Your committee recommends that the following paragraph be substituted for the one now appearing in the Manual (the change consisting of the substitution of "½ in." for "⅜ in."):

(3) Within proper limits a slight variation of the gage from standard is not seriously objectionable, provided the variation is uniform and constant over long distances. Under ordinary conditions it is not necessary to regage track if the increase in gage has not amounted to more than ½ in., provided such increase is uniform.

Under special instructions, your committee took up the question of easement curve formula and has done considerable work upon it in order to get this formula in shape for the Manual. In order to settle upon lengths of spiral a circular was sent to the members and a tabulated list of replies is presented.

It was found necessary, in order to determine the easement curve formula, to have a definition for "degree of curve." The committee presents tabulated replies to Circular No. 110 on this subject, and a discussion of the question by Prof. C. Frank Allen, Prof. Wm. G. Raymond, and others, which will be of benefit to the association and may help solve this problem. (Appendix B.)

MAINTENANCE OF LINE AND ALINEMENT—RECOMMENDED PRACTICE.

Adjustment of Curves with consideration as to Easement Curves:

Easement curves should be used on all curves requiring an elevation of 2 in. or more.

The choice of easement curves should be governed by the ultimate possibilities as to speed, with consideration as to probable revision of the worst features of alinement, rather than by existing schedule speed.

On curves of 6 deg. and over, which are limiting curves as to speed, easement curves not less than 240 ft. long should be used.

On curves of less than 6 deg. which are limiting curves as to speed, easement curves should be used whose length in feet is not less than 5 1-3 times the speed in miles per hour calculated for an elevation of 8 in.

On curves which are not limiting curves as to speed, easement curves should be used whose length in feet, when the rail is elevated for the ultimate speed, will be not less than 30 times the elevation in inches nor less than two-thirds the

ultimate speed in miles per hour times the elevation in inches.

Longer easement curves than the minimum lengths recommended may be used to advantage and often with increased convenience in their application, but any considerable increase in length is wholly unnecessary and should never be made without careful consideration as to the effect on cost. The minimum length should be used in all cases where a greater length would adversely affect the degree of curve.

Easement curves should be used between curves of different degree in the same way that they are used between curves and tangents.

The curve elevation should be run out in the same distance as the length of easement curve, with no elevation on tangent and full elevation on the circular curve.

Any form of easement curve is satisfactory in which the degree of curve increases with the distance; in which the rate of increase in degree of curve can readily be changed to suit each particular case, so that the length of easement curve shall be the same as the distance in which the outer rail is raised from zero to full elevation; which can be run in by deflection or offset, with chords of any desired length, and which is of the general type of Searles, Crandall, Holbrook, Talbot or cubic parabola.

Properties of the Split Switch.

This sub-committee submits:

(1) Revised formulas for determining the properties of the modern split switch.

(2) A table of the properties of frogs and switch rails for use on roads using rail weighing 80 lbs. per yard or less.

(3) A similar table for roads using rail weighing more than 80 lbs. per yard.

Until all of the above points are definitely determined, we feel it would be of no avail to figure the leads and other functions of the entire turnout.

In the tables submitted, the dimensions of the frogs are so computed that—

(1) A 36-in. angle-bar splice may be applied, without clipping, to a frog made of 80-lb. rail.

(2) A 36-in. angle-bar splice may be applied, without clipping, to a frog made of 110-lb. rail.

In both tables the frogs from No. 9 to No. 15, inclusive, have been made of sufficient length from point to toe to permit of being made spring frogs, if so desired.

The switch angles are chosen arbitrarily, after some trial, and are kept as small as seems consistent and of as nearly the same angle for the same number of frog as practicable; the committee having found from comparison of the results of various computations that for any given frog, whether the heel distance remains constant and the switch angle varies or the switch angle remains constant and the heel distance varies, the change in the degree of the lead curve is practically the same for equal changes in the length of the switch rail. So that, considering the switch angle constant and knowing the length of the lead and radius of the lead curve for any given length of switch rail and number of frog, the length of lead and radius of lead curve for any other length of switch rail with the same frog may be much more easily computed than when different switch angles are used with the same number of frog.

Conclusions.

Your committee recommends the adoption of the following conclusions:

(1) That the formulas for the functions of the split switch proposed be approved as good practice.

(2) That the properties of the frogs and switch rails given in the accompanying tables be approved as good practice.

(3) That the degree of curve be defined as the angle subtended by a 100 ft. chord.

(4) That all curves be spiraled which would require 2 in. elevation for the highest possible speed.

(5) That wide gage, due to worn rail, within the safe limits of wear, need not be corrected until the excess over the gage is equal to or exceeds ½ in., and that it should then be corrected by closing in.

(6) That paragraph (b), page 60, of the Manual, under the heading of Maintenance of Line and Alinement, be withdrawn and the version submitted in the body of this report substituted.

The report is signed by L. S. Rose (C., C., C. & St. L.), Chairman; C. E. Knickerbocker (N. Y., O. & W.), Vice-Chairman; E. C. Blundell (C., St. P., M. & O.), Garrett Davis (C., R. I. & P.), T. C. Hickey (M. C.), C. B. Hoyt (N. Y., C. & St. L.), J. B. Jenkins (B. & O.), C. E. Lindsay (N. Y. C.), G. J. Ray (D., L. & W.), S. S. Roberts (Univ. of Ill.), R. O. Rote Jr. (L. S. & M. S.), John C. Sesser (Cont.), F. A. Smith (Cons. Engr.), R. D. Sarbuck (M. C.), R. A. Van Houten (L. V.), W. D. Wheeler (M. & St. L.), A. A. Wirth (Penn. Lines).

Discussion.

Mr. Rose: In order to get the report before the convention, I think it would be well to have the conclusions read. I move that conclusion No. 1 be adopted.

This conclusion was adopted without discussion.

Mr. Rose: Referring to conclusion 2, it was the intention of the committee to prepare tables for frogs and switches which would meet the varied experience—which would be good for any railroad, and could be used by all. For that reason the different lengths shown here were given.

A long discussion followed, many members objecting to the adoption of the tables as given because of the great number of lengths included. They thought the number should be reduced to as few as possible.

Mr. Cushing (Penna.): At present we get along with two lengths of switches, 18 and 30 ft. I do not mean to argue those are the only and best lengths to use, but I believe that all of us can get along with at least three lengths of switches, and I do not think they need to differ by 2 ft. all the way up.

Mr. Rose: It is not the intention of the committee to recommend that all of these shall be used, but in canvassing the question we found it would be impossible to get all the members of this association to agree on three lengths of switches. Any three we might take would not suit everybody and the table can be used by any road that wants to use it after it is adopted.

A. W. Thompson (B. & O.): The figures as worked out are not theoretical all the way through?

Mr. S. S. Roberts (Univ. of Ill.): Not entirely. If you have them theoretical all the way through, you will have fractions of inches and every particular frog would be different, but we have tried to get something, after considerable thought, that might, if possible, be reconciled to the various practices. Not the practices of any one road, but something if any road did use it would not go very far wrong. The purpose of submitting this table of frogs and switch points was simply to get an exact basis from which to revise the functions of turnouts that were submitted last year.

Mr. Cushing: One of the great results to be accomplished by this association is the reduction of the large differences in practice and in material used on the different railroads. It not only helps the railroad company, but it helps the supply man. If this table goes out in this way, one road picks one thing and another picks another and we are as widely apart as we are at the present time. Even on a large railroad system the engineers don't agree on these matters. Even on our own system we would probably have as much of a table as this is if we were not required to come together and agree on something, and I think this committee can do the same thing and, working from proper principles, establish what seems to be a good length for these switches and say that that is what they recommend.

Mr. Wendt: Mr. Chairman, it seems to me that the tables are hardly in proper form to be printed as part of the Manual, because they involve a number of assumptions on which this association has never taken action. These tables involve switch angles, lengths of frogs and lengths of switches and the association has not placed its stamp of approval as yet on any standards for any of these features.

Hunter McDonald (N. C. & St. L.): Referred to the instructions of the Board of Direction to this committee, and said if the committee had not complied with that instruction, he did not know how else they could do it.

Mr. Roberts: One of the criticisms of this committee last year was that the lengths of switch rails as recommended could not be cut from commercial lengths of rail without waste. We have tried to get a lead that would contain between the heel of the switch point and the point of the frog, the commercial lengths of rail, or such fraction thereof that the piece cut would not be wasted. We selected 18 and 22 ft. so that in cutting the rail we could use the piece for another point.

C. C. Wentworth (N. & W.): I move that the sense of the committee as a whole be given to the effect that there be three lengths of switches and three lengths of frogs.

J. V. Hanna (K. C. Ter.): I don't know that the recommendation of a large number of switch points obligates any railroad to adopt all of them for its standards, and I can see considerable help to the engineers figuring these things out in having these things before them.

T. H. Gatlin (So. Ry.): Within the last year our road has used the lead curve and the formulas for the functions of

the switches worked up by the committee, and in special work the formulas for the functions made a very beautiful fit in actual work in the field.

A. S. Baldwin (I. C.): This motion is not apropos to the question before the house. This committee has given a table and furnished a resolution to the effect that the properties of frogs and switch rails given be approved as good practice. They have established in these tables a ratio between the angle and the length of frog and the switch point to be used with it. The question for us to decide now, is this ratio correct? There isn't a question before the house as to whether we should be restricted to certain lengths of frogs, properly speaking.

J. B. Jenkins (B. & O.): The motion is to have three lengths of switches and also three lengths for all frogs. It seems to me the expense of having three lengths of switches is somewhat different from having three lengths of frogs. While it may be possible for any road to limit itself to three lengths for the switch points, yet there are certain physical difficulties in the way of restricting the lengths of all frogs to three. I would, therefore, offer an amendment to the motion to eliminate the reference to the length of frogs, so that the two things can be considered separately.

Mr. Wentworth: I did not mean to make only two frogs 20 ft. long; I meant to start with No. 2 frog, 15 ft. long and increase the length as required in order to get the angle.

L. C. Fritch: This discussion only shows how impracticable it would be to select any number of switch rails and frogs that would be acceptable to all roads. Personally, I think the table of the committee should stand, and let each road adopt as its standard the number of switch lengths and frog lengths it desires.

J. A. Atwood (P. & L. E.): In order to bring this discussion to a conclusion I move an amendment to the motion, that conclusion No. 2 be made to read as follows: "That the properties of the frogs and switch rails given in accompanying tables be approved as good information," and that the following also be added:

"2 (a): That the number of switch points and frogs used in general practice be reduced to as small a number as possible."

This motion, as well as Mr. Wentworth's to instruct the committee to have in their tables only three lengths of frogs and only three lengths of switch points, was lost.

Conclusion No. 2 was then adopted.

The secretary read conclusions 3 and 4.

A. L. Kuehn (Amer. Creo. Co.): I want to ask the committee how the 2 in. elevation was arrived at.

Mr. Jenkins: This was arrived at in connection with the proposition to spiral the curve, not so much for schedule speed as for the degree of curve itself; that is to say, a 4 deg. curve is good for a certain speed with 8 in. super-elevation. If you put a shorter spiral in that curve, that spiral will limit the speed to something lower than the limits set by the degree of curve itself, and if we make spirals part of the permanent alinement, which seems to be the practice of the majority of the roads, then by putting in a shorter spiral, you would put a permanent reduction of speed on that part of the line, which is not called for by the maximum load. The 2 in. elevation is arrived at in connection with the rate of runoff. With the rate of runoff proposed, the 2 in. elevation would give speeds of over 45 miles an hour, and a uniform offset between the tangent and circular curve of ½ in. The offset of the spiral at the middle point would be only ¼ in., and at the end of the spiral 2 in.; on other words, the engine will travel over considerably more than half the spiral before the flanges of the wheel will strike the rail, and a spiral much shorter than that would be, you might say, an imaginary spiral, and not one that would have any direct influence on the qualities of the track.

Mr. Kuehn: It seems to me before adopting this conclusion we should determine on the proper length of spiral for different curves and different speeds.

Mr. Ewing (P. & R.): I move the adoption of the committee's conclusion 4, with the change of the word "possible" to "permissible."

Mr. Fritch: The spiral should not be specified. It is impracticable to specify any uniformity as to the application of the spiral, because the location of the curve governs largely. A curve at the foot of the grade will require a spiral of different character from one at the top of the grade. Therefore, I think it would be impracticable to specify any uniformity in regard to the use of the spiral.

Mr. Ewing's motion was put to vote and carried.

The secretary read conclusions 5 and 6, which were adopted.

The secretary read the matter on "Maintenance of Line and Alinement—Recommended Practice."

Mr. Rose: I move the adoption of conclusion 6 carries with it the adoption of the matter just read by the secretary. (Motion carried.)

Mr. Rose: I move the adoption of the resolution on the clear width of standard flangeway.

This precipitated a discussion on the question of an increase in the width of wheel flanges by the Master Car Builders' Association, and also as to whether or not the American Railway Association had passed on this question of the standard width of flangeway.

Mr. Rose: The question of the thickness of the flange is a pretty serious one. You cannot make it any thicker without striking the point of the frog. The M. C. B. Association recommends a 1⅞ in. flangeway, but with a 1⅞ guard rail distance you cannot guard the frog point. They have not only drawn the flange high, but made it thicker, and the only way we can help them is to maintain the 1¾ in. flangeway at the guard rail.

Mr. Ewing: The committee has illustrated this matter very correctly and stated the facts. As I understand it, the M. C. B. Association did, within the past year, increase slightly the thickness of the flange. They concluded that greater strength was needed at a point slightly above the tread of the wheel. They have taken into consideration a 1¾ in. tread and reinforced their flangeway to meet that condition. I also believe that the American Railway Association at its last meeting definitely decided that 1¾ in. was the proper flangeway.

Mr. Churchill (N. & W.): I wish to amend the resolution of the committee to this effect: That the clear width of standard flangeway used for all frogs be 1¾ in., and between rails and guard rails be 1⅞ in.

Mr. Wentworth: The reason for holding to 1¾ in. through the frog is in order to lessen the jump which the wheel has to make over the flangeway going through the frog. That should be 1¾, if we can make it; I think after awhile we can. Just now we cannot, and I am sure that 1⅞ on the guard rail is in line with what we will have to do pretty soon.

Mr. Cushing (Penna.): After thorough investigation the American Railway Association adopted a 1¾ in. flangeway, but on their attention being called to it they were not satisfied with the language in which it was expressed and they have asked this association to formulate a recommendation in better language and that communication was turned over to the chairman of his committee, and he had that before him in making this recommendation.

Mr. Churchill's amendment was put to vote and lost.

The Vice-President then put the question on the adoption of the resolution, which was carried.

Conclusions 5 and 6 were adopted without discussion and the specifications for frogs and switches received as a progress report.

T. H. Gatlin (So.): I move, in the first paragraph where it provides that the company shall be notified of any omissions in the drawings or specifications, that the following be added at the end of the sentence: "Before proceeding further with the construction of the work."

The Vice-President: The committee will consider that in their revision of the specifications for final presentation.

Paragraph 1 (b) on facing point switches was accepted and the subject considered closed.

Mr. Roberts: In regard to completing the table of switch lengths, I ask how we should do that. In figuring in accordance with any exact formulae you obtain leads which will give such lengths of rail between the toe of the frog and the heel of the switch rail that it will be necessary to cut the rail. By modifying the theoretical lead very slightly—by making it a fraction shorter or longer than the absolutely theoretical lead—you can obtain a lead which differs in curvature and length only slightly from the theoretical lead and obtain one in which you can use commercial lengths of rail, or use both pieces if you cut the rail. The opinions advanced to us in regard to such leads are varying—some insist we shall stick absolutely to the theoretical lead, and some that we should adopt the practice where you will not have to cut the rail, or if you do, you can use both pieces. Before figuring out these tables and completing them, the committee would like to know what is the wish of the association. Shall we use the absolutely correct theoretical lead, or shall we use the practical lead?

Mr. Ewing: I move the committee prepare a table of practical leads conforming closely to the theoretical.

Motion carried.

TIES.

The following subjects were assigned to your committee by the Board of Direction:

(1) Continue the compilation of statistics upon the life of ties, both treated and untreated, and the causes of failure. Present summary compilation of reports received and draw such conclusions therefrom as the statistics warrant at the present time.

(2) Prepare critical review of the general question of the present and future status of the tie supply, the various methods heretofore adopted for reducing the yearly demands on the timber supply, and what general lines of investigation and change in existing methods may seem most desirable to be followed so as to secure the best results in the future.

(3) Collect statistics on the extent of the use and the life of metal or composite ties up to the present time, with illustrations and descriptions of the most successful designs, and draw such conclusions as the conditions may warrant.

Each subject was assigned to a sub-committee.

Compilation of Statistics.

The association adopted at the 1902 convention certain forms to be used in the compilation of statistics. It is now deemed advisable to make some changes in these blanks in order that the destruction between so-called long and short lived, treated and untreated ties may be clearly brought out, together with further information it is thought desirable to collect.

The committee enumerates the changes in the new blanks and gives the reasons therefor.

Timber Supply.

The sub-committee on Forest Supplies has during the past year devoted its attention principally to investigating policies which could be followed at this time to encourage the more economical uses of the timber supplies still on hand. This problem is such a large one that it has not been thought desirable to make more than a progress report.

It has been found that the most important need for most of the railroads at this time is definite technical information. It is not sufficient to know that timber supplies are being exhausted, but one should also know exactly what these supplies are, and what the rate of exhaustion is, and what the probable rate of re-growth is in any particular region upon which that particular road is depending. Your committee feels very strongly that one of the most important steps which the various individual roads could take would consist in the appointment of technical men in connection with their timber departments to study this problem with the greatest care.

The committee then refers to the two meetings on conservation of natural resources held at Washington during the past year, and in conclusion repeats some of the recommendations in last year's reports, urging their immediate consideration:

(1) Use chemically treated ties wherever possible.

(2) Protect such treated ties against mechanical wear by means of tie plates, screw-spikes, etc.

(3) Enforce the tie specifications rigidly with particular reference to the rigid exclusion of small ties.

(4) Co-operation among the roads in any given territory, looking toward the adoption of standard tie specifications, with particular reference to making it impossible for contractors to furnish ties cut from small trees, which would naturally form sources for future tie supplies.

(5) Adopt measures for reducing forest fires.

(6) Encourage the owners to re-forest their lands either by re-planting or natural reproduction.

(7) Use the proper means to aid and assist in the investigation of tax laws as far as they pertain to forest lands with a view to having legislation enacted which would make it possible to hold lands with growing timber for the purpose of future tie production.

Metal and Composite Ties.

The sub-committee inspected a large number of such ties and show numerous illustrations of them, both in detail and in the track.

Carnegie steel ties were reported on from the Buffalo, Rochester & Pittsburgh; Bessemer & Lake Erie; New York Central; Pittsburg & Lake Erie; Union R. R.; and the Baltimore & Ohio. Other metal ties reported on were the Seitz, laid in the Pennsylvania Lines West in 1904, but removed in 1905; the Hansen, laid in the Pennsylvania Lines, main track, in 1905, but removed shortly to a side track, where they remain; the Bouton, laid in the B. & O., and reported to be giving good service; and the Snyder tie, which is a steel shell, filled with asphalt and crushed stone. A number have been in Pennsylvania track (not main track) for about a year and have given satisfactory service.

Some Buhrer combined wood and steel ties have been in a freight track of the Lake Shore for two years and the track is in good condition.

The concrete ties include the Buhrer, laid at various places on the Lake Shore, on the Pennsylvania Lines, the Chicago & North-Western, the Lake Erie & Western and the Chicago Junction. They were removed from the last-named after a few months on account of breaking. The Kimball tie, laid in the Chicago & Alton, where there was trouble due to improper spiking, injuring the concrete and causing cracking; and in the New York, Chicago & St. Louis, where they have given good service. Percival ties laid in the Pittsburgh & Lake Erie and removed on account of failure; and Affleck, Chenoweth, Keefer, Hickey and Alfred ties, all of which failed in experimental application.

The committee concluded that an improved form of steel tie of the Carnegie type, with metal plate over the insulating fiber and with the wedge-clip rail fastenings, seems to be very promising. Experiments with the same should be extended, and results carefully watched and reported to the association.

No form of reinforced concrete tie has been made which is suitable for heavy and high-speed traffic, but the committee believes a properly reinforced concrete tie, with proper fastenings, may be found economical in places where speed is slow, and where conditions are especially adverse to life of wood or metal.

Conclusions.

Your committee recommends the adoption of the following conclusions:

(1) That Forms 1, 1-A, 1-B, 1-C and 1-D be withdrawn from the Manual and Forms M. W. 301, M. W. 302, M. W. 303, M. W. 304 and M. W. 305 be substituted.

(2) That the conclusions in reference to Timber Supply be approved.

(3) That the conclusions of the committee in reference to metal and concrete ties be endorsed.

The report is signed by E. B. Cushing, (S. P.), Chairman; E. G. Ericson, (Penn. Lines), Vice-Chairman; J. B. Austin, Jr., (L. I.); W. F. H. Finke, (S. R.); E. E. Hart, (N. Y., C. & St. L.); E. D. Jackson, (B. & O.); F. B. Oren, (I. C.); H. J. Simmons, (E. P. & S.W.); A. W. Thompson, (B. & O.); Hermann von Schrenk, (R. I.-Frisco).

Discussion.

The secretary read conclusion 1 of the report of the committee.

L. C. Fritch (I. C.): I suggest that in Form M. W., 303, the column heading "siding" be made "side." Siding usually means a parallel track to the main track, used as a passing track. Side would conform to the other forms.

The President: The committee accept that suggestion.

Mr. Thompson: I would like to suggest to the convention that these forms be carefully considered. These forms, if they are adopted, should stand for a long time, as the data will be collected in accordance with the forms. If the forms are changed later it will mean going back over the record and doing a great deal of work.

Mr. Fritch: I notice in form 304, statistics of treated ties, that there is no column provided for oak.

Mr. Thompson: The two blank columns were left for that purpose. We had in mind first putting in one of the columns inferior oaks, having in mind red oak and some of that class. We thought that the two extra columns and the columns headed as shown on this form would cover all the timber that would be treated.

The secretary read, one at a time, the seven paragraphs of the Timber Supply conclusions referred to in conclusion 2.

W. C. Cushing (Penna.): I suggest that the word "possible," in the first paragraph, be changed to "practicable." The matter of cost enters into the subject as to whether ties should be treated or not.

The committee accepted the change.

The secretary read paragraph 2.

Mr. Fritch: I suggest that all ties should be protected in the same way; that the word "treated" ought to be omitted—"protect ties against mechanical wear, by means of tie plates, etc."

The President: You would omit the two words "screw spikes?"

Mr. Fritch: Yes.

Mr. Thompson: Treated ties were specified there because it was thought that after putting your money into treatment you should do everything possible to further the life of the ties. Where timber is cheap it would not pay to put on tie plates, particularly on lines with light traffic.

Hunter McDonald (N. C. & St. L.): Do I understand that the adoption of this paragraph carries with it the recom-

mendation of this association that all ties are to be treated with tie plates and screw spikes and that screw spikes will take the place of ordinary spikes? It seems to me that this is rather a radical departure and ought not to be passed over without some discussion.

Mr. Thompson: I was not on the sub-committee on this subject. I would like to mention that the committee here are agreeing to some changes that came up in discussion, and it is the minority part of the committee that are agreeing to some of these changes. There was considerable discussion in regard to placing tie plates on all treated ties.

Mr. Cushing: I offer the following substitute:

"Protect all ties which wear out by mechanical wear with tie plates. In the case of treated ties the use of screw spikes should be considered as being possibly preferable to the common track spike."

Mr. Thompson: If you can get additional life in the treated tie by using tie plates to offset the mechanical wear, it should be done. That was the idea of the committee in putting it that way.

Mr. Cushing: That is very true, but it also applies to other ties which are destroyed by mechanical wear, as well as to treated ties. It is a case of figuring out the relative cost to ascertain whether it is practicable to do so.

After some discussion, Mr. Cushing's motion was altered so as to make paragraph 2 read: "Protect all ties against mechanical wear."

Mr. McDonald: I prefer screw spikes wherever expense has been incurred for treating the ties, but I have heard a number of objections to their use on account of the fact that they necessarily attach the tie to the rail. In case there is any lack of sufficient ballast underneath, the tie follows the rail up and down. An ordinary spike, on the other hand, pulls out of the tie slightly, allowing the rail to move. Does the committee think screw spikes have been used on American roads to such an extent that they are warranted in recommending their use at this time?

Mr. Thompson: No.

Mr. Cushing: I agree with Mr. McDonald. I don't think we should now commit ourselves to an expression of an opinion so radical. Screw spikes are being tried in this country in more or less large quantities and that investigation should continue.

M. L. Byers (Mo. P.): All ties are subject to mechanical wear, and if we attempt to protect all ties against mechanical wear we will be protecting ties which actually fail by decay. It seems to me that the motion should read "protect all ties against failure from mechanical wear."

Mr. Cushing: That is right.

J. A. Atwood (P. & L. E.): I think the force of the second paragraph will be lost if Mr. Cushing's motion is carried. The purpose, it seems to me, is to call attention to the absolute necessity of protecting treated ties against mechanical wear, if you are going to get the value of the treatment.

Paragraph 2, in the final form as suggested by Mr. Byers, was adopted.

E. F. Wendt (P. & L. E.): Conclusion No. 6 is eminently proper, but how can we encourage owners to re-forest their land? There are no taxes in certain small cities in Germany, because the city owning the forest nearby derives a sufficient revenue from the matured timber to pay the entire expenses of the city. Paragraph 6, it seems to me, should be dwelt upon at some future time in order to inform us just in what way re-forestry can be encouraged.

Mr. Fritch: It seems to me these suggestions properly belong to the committee that is co-operating with the National Conservation Committee, and, going a little ahead, I think that 7 rather goes into the domain of politics. It seems to me the province of this committee is to treat of the technical side of the question and devise ways and means for extending the life of ties. This question of re-forestration and assisting in securing favorable tax laws, is a subject that should be referred to the other committee.

The President: You do not mean No. 6? You are referring to No. 7?

Mr. Fritch: 6 and 7 both.

Prof. S. N. Williams spoke of the need of fire protection, and continued: Paragraph 6 is very important, but I do not see how this association can do much except by co-operation with state or national government. Japan and Russia, I understand, are not only protecting their forest, but are exporting large amounts. European governments are making a specialty of reforestration.

W. H. Hoyt (D. M. & N.): We spent a good many thousands of dollars and a good deal of time in fighting forest fires last summer. We had 75 to 300 men fighting fire two or three weeks. I know that the other railways in the northern part of Minnesota did a great deal in the same line. In regard to paragraph 6, in our district there is at the present time one firm putting out 6,000 acres of Scotch spruce, replanting the land. They are importing these young trees from the old country, getting them in here in about their second year growth, just started, and are hand-planting them in the country. The railways are encouraging this by making a special effort to see that they are protected from fire. We keep our rights of way cut once or twice every year, mowed down and burned, and if there is any sign of fire anywhere in the country our section gangs and bridge foremen get after it without any delay, whether it is on the right of way or anywhere near the right of way, started by the railway or from any other cause. A number of times, we have sent crews of men a mile or two into the country to take citizens and farmers out from their homes and bring them into the open country to help out and keep the trees from burning up. I think the recommendation made in paragraph 6 should stand as a proper encouragement to taking measure along that line.

Mr. Hall (Forest Service): It seems to me that paragraphs 5, 6 and 7 are virtually three sides of the same question. We are not to have effective measures of reducing forest fires unless at the same time we solve the question of forest land taxation; we are not to have effective re-forestration of lands, either by planting or by natural reproduction, unless we also solve the tax question and the fire question.

C. S. Churchill (N. & W.): I think there is some specific work that this association can do in reference to paragraph 5, that follows out the practice that we find in Europe and also in some sections of this country, namely, cutting ditches alongside of the right of way, and even outside of the right of way. It is kept clean of all undergrowth, in order that fire may not spread beyond the limits of control of the railway. And another feature that railways can encourage is the sale for the small timber that is left lying in the forests. You never see small timber lying around in the forests in Europe; it is always cut up and taken out of the forests and sold.

Prof. W. D. Pence (Univ. of Wis.): E. M. Griffith, state forester of Wisconsin, some months ago solicited co-operation between the track forces of the various railways and the state fire wardens. He gave illustrated lectures to employes of the track departments. It is quite evident that the principal railways in Wisconsin are in the future to give more attention to the prevention of forest fires. Among these things is the adoption of special spark arresters and experiments are in progress along that particular line. Large territory in Wisconsin is being re-forested.

J. B. Berry (C., R. I. & P.): For the benefit of the committee and quoting Mr. Thompson's remarks in regard to the failure of screw spikes, we made frequent examinations of their use and in every case where it was reported that they did not do their work, we found it was because they were not put in in accordance with instructions. When we fixed them as they should have been in the first place, they did their work under very trying conditions in first-class manner.

Attention was called to the fact that zinc or lead treated ties seriously interfere with track circuits for automatic signals. Several members gave their experiences.

The conclusions of the Timber Supply section of the committee, as amended, were adopted.

Conclusion 3 referred to the two paragraphs which, in the above abstract of the report, immediately precede the conclusions. The first paragraph was read.

Robert Trimble (Penna.): I understand that one of the things we are trying to steer clear of is being an advertising medium. I do not believe it is policy to adopt this as it is worded. I suggest this modification: "An improved form of steel tie, as shown by Fig. 1, of the I-beam type, with metal plate over the insulating fibre, and with the wedge clip rail fastenings, seems to be promising. Experiments should be extended and results carefully watched and reported to the association."

J. O. Osgood (C. of N. J.): I would suggest that it read, "an improved form of steel tie of the general type shown by Fig. 1, with metal plate," etc.

A. H. Rudd (Penna.): We still have our old friend, the track circuit, with us. That fibre insulation, as shown in Fig. 1, will last long enough to get it in—perhaps a few months longer to take it out. I believe that we should add to the instructions that if experiments are made with these they should be made with the track circuit also, because the track circuit, with automatic signals is going to be increased in this country very appreciably, and it cannot be neglected and it cannot be worked successfully under any known conditions at the present time, where the track circuit is so arranged that the signal will assume a stop position when the track is

short circuited by the wheels, if you also short circuit it at every tie.

Mr. Atwood: The Pittsburgh & Lake Erie has 3,000 I-beam steel ties in service. They have been in there nearly two years. They are insulated, and up to the present time there has been no difficulty. They are as easily maintained as the wooden ties and at no greater expense.

Mr. Rudd: We installed, on the Pennsylvania a section three-quarters of a mile long, and the first train that went over it cut out the insulations on some 40 or 50 ties, and we maintained this experimental track some six months, with the signals removed, and orders out that there was no automatic block on those tracks.

Mr. Thompson: The experience of the B. & O. in the use of steel ties of the I-beam type, has not been as successful as that quoted by Mr. Atwood. One of the points I would like to bring out forcibly is the movement of the steel ties of the I-beam type in the ballast. They skew around very badly, and in a mild section of this type of tie, compared with a mild section of the wooden tie, the cost of maintenance was very much in excess of the wooden tie. Also there must be taken into consideration the additional quantity of ballast necessary with the I-beam tie. That is a very large factor where stone ballast is used. No mention is made in the report of the damage occasioned steel ties by derailment. On coal carrying railroads, where there are steel cars of large capacity, broken flanges contribute to a large percentage of the derailments. On the B. & O., where a derailment occurred from a broken flange, nearly all the ties in that immediate section were either destroyed or so badly damaged they had to be taken out of the track. Another thing is the damage to the equipment. The flanges on all the wheels are either broken or chipped so badly that they have to be removed.

Mr. Trimble: Our trackmen were continually complaining about our steel ties moving in stone ballast. We would have them lined up square with the rail, but inside of a week they would be out of line and irregular. Finally the trackmen had so much trouble with them that they took them out, really against the protest of the department.

Mr. Wendt: We are conducting an experiment on our four-track road, we laid about one mile of steel ties and a mile with new wood ties, at the same time, on adjacent tracks. New rails were laid at the same time, and the track completely ballasted with 12 in. of stone. Track circuits are maintained within the limit. The speed of trains will average 20 miles per hour at this point. For the first 16 months trackmen were instructed to do no surfacing on either the steel or wood ties. At the end of 16 months both sections were resurfaced and a record made of the later expense. The expense for the 16 months was simply for patrolling and general supervision. The results of the experiments are reassuring, and the labor expense is rather significant, so that we feel that the committee is taking the right stand when it states in the last clause that experiments in steel ties should be extended and results carefully watched and reported to this association.

E. R. Lewis (M. C.): The experience with steel ties is that they work very much better in fine ballast than in coarse, and better in sand than in ballast.

Prof. Dufour (Univ. of Ill.): Any tie which has a smooth surface throughout its entire length will shift. In Europe I saw them taking up miles and miles of this very same general form—the channel form—and the foreman told me they shifted, they could not hold them in the ballast, and in case of a derailment they were very poor.

Mr. Thompson (B. & O.): I move that the first paragraph be received as information.

Mr. Fritch: I suggest to the committee that one of the important elements of this investigation is the traffic condition, both with regard to speed and the amount of traffic. A steel tie may perform very satisfactorily under slow speeds, but it may be a different question under high speed, and, therefore, it should be one of the elements to be considered in each case.

Mr. Cushing: I offer an amendment that the first sentence be stricken out, leaving the recommendation that experiments with the steel tie should be extended and results carefully watched and reported to the association.

The amended motion was carried.

The second paragraph was adopted.

Mr. Fritch: I move that conclusion 3 be changed to read: That the conclusions of the committee in reference to metal and concrete ties be received as information.

The motion was carried.

WOODEN BRIDGES AND TRESTLES.

The work assigned by the Board of Direction was as follows:

1. Continue the revision of the specifications for structural timbers, co-operating with Committee Q of the American Society for Testing Materials and other committees on the subject, with a view, if possible, of preparing a uniform standard specification.
2. Prepare a list of recommended safe unit stresses for structural timbers.
3. Revise the report on standard names for structural timbers.
4. Study the principles and methods of pile-driving, and collect data relating to the current practice.
5. Report on best method for classification of pine timber for structural purposes in place of classification by botanical names.

The committee was divided into the following sub-committees:

A. To consider Items 1, 3 and 5.
B. To consider Item 2.
C. To consider Item 4.

Standard Specifications for Bridge and Trestle Timbers.

The specifications as revised and adjusted by joint action of Sub-Committee A and committees from the American Society for Testing Materials and the Yellow Pine Manufacturers' Association are presented for adoption.

The specifications for timber piles have also been revised by Sub-Committee A to conform to the other specifications for timber, and have been materially simplified and condensed. They are also presented for adoption.

Safe Unit Stresses.

The report includes a large number of diagrams showing the relation of lower to higher groups in the results of tests for various timbers, a comparison of certain older tests, mainly on full-size sticks, referred to in the bibliography published in 1907, and a table of safe unit stresses which are recommended for adoption by the association. The principles relating to the determination of these unit stresses, various details connected with the tests on which they are based, and references to the unit stresses employed in practice are given in the body of the report.

Piles and Pile Driving.

Two circulars were prepared by Sub-Committee C and sent in July to members of the association and a selected list of other engineers and contractors. An analysis of the 47 replies received relating to a part of the questions is presented in this report, the data relating to the remaining questions being reserved for further study.

The only topic discussed is "Overdriving Piles." The committee regrets that it failed to receive a larger number of photographs or descriptions of overdriven piles where such have been found by later excavation or when withdrawn at the time of construction. It is to be hoped that anyone who sees this report and can thus render a real service to the profession will send the desired information to the committee.

As an important aid to the thorough study of the subject of piles and pile-driving much time was spent in preparing a bibliography which is printed as an appendix to the report. The references were selected from a larger number as containing information of value, and for convenient use are classified under suitable heads. A series of definitions and a brief historical sketch of the subject are presented as an introduction.

Appendix A.

STANDARD SPECIFICATIONS FOR BRIDGE AND TRESTLE TIMBERS.

(To be applied to solid sticks and not to composite members.)

1. Except as noted, all timber shall be cut from sound trees, true and straight, and sawed standard size; shall be square edged, close grained, solid and out of wind; free from defects such as injurious ring shakes and crooked grain, unsound or loose knots, knots in groups, decay, large pitch pockets, or other defects that will materially impair its strength.
2. Rough timbers sawed to standard size means that they shall not be over ¼ in. scant from the actual size specified. For instance, a 12 in. by 12 in. timber shall measure not less than 11¾ in. by 11¾ in.
3. Standard dressing means that not more than ¼ in. shall be allowed for dressing each surface. For instance, a 12 in. by 12 in. timber after being dressed on four sides shall measure not less than 11½ in. by 11½ in.

No. 1 R. R. Grade. Longleaf Yellow Pine and Douglas Fir.

4. Stringers.—Longleaf pine shall show not less than 85 per cent heart on the girth anywhere in the length of the piece; provided, however, that if the maximum amount of sap is shown on either narrow face of the stringer, the average depth of sap shall not exceed ½ in. Douglas fir shall show not less than 90 per cent heart as measured above. Knots greater than 1½ in. in diameter will not be permitted at any section within 4 in. of the edge of the piece.

5. Caps and Sills.—Shall show not less than 85 per cent heart on each of the four sides, measured across the sides anywhere in the length of the piece; to be free from knots over 2½ in. in diameter.

6. Posts.—Shall show not less than 75 per cent heart on each of the four sides, measured across the sides anywhere in the length of the piece, and to be free from knots over 2½ in. in diameter.

7. Longitudinal Struts or Girts.—One face shall show all heart; the other face and two sides shall show not less than 85 per cent heart, measured across the face or sides anywhere in the length of the piece, and shall be free from knots 1½ in. in diameter and over.

8. Longitudinal X Braces, Sash Braces and Sway Braces.—Shall show four square edges and not less than 80 per cent heart on two faces, and shall be free from knots over 1½ in. in diameter and over.

9. Ties and Guard Rails.—Shall show one face all heart; the other face and two sides shall show not less than 75 per cent heart, measured across the face or side anywhere in the length of the piece; shall be free from knots over 2½ in. in diameter and where surfaced the remaining rough face shall show all heart.

No. 2 R. R. Grade. Longleaf and Shortleaf Yellow Pine, Douglas Fir and Western Hemlock.

10. Stringers.—Shall be square-edged, except that it may have 1 in. wane on one corner. Knots shall not exceed in their largest diameter one-fourth the width of the face of the stick in which they occur, and shall in no case exceed 4 in. Ring shakes shall not extend over one-eighth of the length of the piece.

11. Caps and Sills.—Shall be square edged with the exception of 1 in. wane on one corner, or ½ in. wane on two corners. Knots shall not exceed in their largest diameter one-fourth of the width of the face of the stick in which they occur, and in no case shall exceed 4 in. Ring shakes shall not extend over one-eighth of the length of the piece.

12. Posts.—Shall be square-edged, with the exception of 1 in. wane on one corner, or ½ in. wane on two corners. Knots must not exceed, in their largest diameter, one-fourth of the width of the face of the stick in which they occur, and shall in no case exceed 4 in. Ring shakes shall not extend over one-eighth of the length of the piece.

13. Longitudinal Struts or Girts.—Shall be square-edged and sound and shall be free from knots 1½ in. in diameter and over.

14. Longitudinal X Braces, Sash Braces and Sway Braces.—Shall be square-edged and sound; and shall be free from knots 2½ in. in diameter and over.

SPECIFICATIONS FOR TIMBER PILES.

No. 1 R. R. Grade.

1. This grade includes white, burr and post oak, longleaf pine, Douglas fir, tamarack, eastern white and red cedar, western cedar, redwood and cypress.

2. Piles shall be cut from sound trees; shall be close-grained and solid, free from defects, such as injurious ring shakes, large and unsound or loose knots, decay or other defects which may materially impair their strength or durability. In eastern red or white cedar a small amount of heart rot at the butt, which does not materially injure the strength of the pile, will be allowed.

3. All piles must be butt-cut above the ground swell and have a uniform taper from butt to tip. Short bends will not be allowed. A line drawn from the center of the butt to the center of the tip shall lie within the body of the pile.

4. Unless otherwise allowed, all piles must be cut when sap is down. All piles must be peeled soon after cutting. All knots shall be trimmed close to the body of the pile.

5. For round piles the minimum diameter at the tip shall be 9 in. for length not exceeding 30 ft.; 8 in. for lengths over 30 ft. but not exceeding 50 ft., and 7 in. for lengths over 50 ft. The minimum diameter at one-quarter of the length from the butt shall be 12 in. and the maximum diameter at the butt 20 in.

6. For square piles the minimum width of any side at the tip shall be 9 in. for lengths not exceeding 30 ft.; 8 in. for lengths over 30 ft. but not exceeding 50 ft., and 7 in. for lengths over 50 ft. The minimum width of any side at one-quarter of the length from the butt shall be 12 in.

7. Square piles shall show at least 80 per cent heart on each side at any cross-section of the stick, and all round piles shall show at least 10½ in. diameter of heart at the butt.

No. 2 R. R. Grade.

8. This grade includes red and all other oaks not included in No. 1 R. R. grade, sycamore, sweet, black and tupelo gum, maple, elm, hickory, Norway pine, or any sound timber that will stand driving.

9. The requirements for size of tip and butt, taper and lateral curvature are the same as for grade No. 1.

10. Unless otherwise specified piles need not be peeled.

11. No limits are specified as to the diameter or proportion of heart.

12. Piles which meet the requirements of grade No. 1 except the proportion of heart specified will be classed as No. 2.

Appendix B.

SAFE UNIT STRESSES.

Diagrams shown on six sheets accompanying this report give a summary of the average results for tests on full-size sticks of seven kinds of timber made during the past six years by the United States Forest Service. Notes relating to the number of tests and the sizes of the sticks are given on each sheet. The results are classified to give the averages of groups of 10, 10, 30, 30, 10 and 10 per cent respectively, and show their relation from the lowest to the highest group.

The relation of the average value for the lowest 10 per cent group to that of the general average for the entire series, expressed as a percentage for each kind of timber is as follows: Douglas fir, 62.8; western hemlock, 80.3; western larch, 71.8; Norway pine, 72.2; tamarack, 62.0; shortleaf yellow pine, 69.1; loblolly pine, 63.3; and the average for all the timbers is 68.2. When arranged according to the kinds of test the corresponding relations are as follows: Modulus of rupture, 61.2; modulus of elasticity, 69.3; shear parallel to the grain, 67.8; compression perpendicular to the grain, 69.3; and compression parallel to the grain, 74.9. The difference between the radial and the tangential shear is not large enough to require special consideration in determining safe unit stresses.

To facilitate comparison between average values and to indicate the range in some cases, the modulus of rupture, modulus of elasticity, and compression parallel to the grain, according to various authorities, are plotted on 11 additional sheets.

Sheet No. 39, reproduced herewith, contains the table of ultimate and safe unit stresses recommended by the committee. Unless otherwise stated the ultimate stresses are the average values for green timber. In cases where it was not possible to secure results for green timber in large sizes, those for partially air-dry timber are inserted in the table.

The average ultimate values for Douglas fir, shortleaf pine, Norway pine, tamarack, and western hemlock were furnished by the U. S. Forest Service. As no recent tests on green longleaf pine in large sticks have been made, the Forest Service gave the following average values, expressed in pounds per square inch, for longleaf pine and Douglas fir, both being partially air-dry:

	Longleaf pine.	Douglas fir.
Modulus of rupture	7,160	6,876
Modulus of elasticity	1,560,000	1,597,000
Shear parallel to the grain	(973)	770
Longitudinal shear in beams	335	313
Compression perpendicular to grain at the elastic limit	572	651
Compression parallel to grain	(4,800)	4,406

It was stated that "since Georgia material, as shown in Circular 115, was of very excellent quality, being almost clear material, the fiber stresses are considerably above the average. The South Carolina material was of a good merchantable quality, and the values shown for it may be considered very good averages." In the above table the values enclosed in parentheses are for the Georgia material (the corresponding ones for the South Carolina material not being given in Circular 115), and therefore require some reduction.

[The committee explains in detail how the different values in the table, sheet 30, were obtained, and gives advice about their use. Space is lacking to reproduce these statements here.]

Appendix C.

PILES AND PILE DRIVING.

Circular letters were sent to the members of the association and to a large number of outside engineers and contractors, and replies, giving the views of 47 railroad engineers (representing 37 roads) and 14 other engineers and contractors, were received:

Kind of Hammer.	Weight of Hammer.	Water Driver. Character of Driving. Soft.	Med.	Hard	Not Given	Land Driver. Character of Driving. Soft.	Med.	Hard	Not Given	Track Driver. Character of Driving. Soft.	Med.	Hard	Not Given	Remarks.
Drop	6,000				1									The allowable heights of drop were generally stated as being varied to suit level conditions.
Drop	5,000-4,000	1	1	1	2			1					1	
Drop	4,500				1									
Drop	4,500-3,200			1										
Drop	3,500				2				2				3	
Drop	3,500-3,000		1	1		1				1				
Drop	3,200				1				2				2	
Drop	3,200-2,800												1	
Drop	3,000	2	1	2	3	2	4	5	2	2	4	3	5	
Drop	3,200-2,200								1					
Drop	3,000-2,500	1	1	1	1				1				1	
Drop	3,000-2,200									1	1	1		
Drop	3,000-2,000	1	1	1		1	1	1	1	1	1	1	1	
Drop	2,800	1	1	1		1	2	2		1	2	2		
Drop	2,700												1	
Drop	2,600								1					
Drop	2,500	1	1	1	1	4	4	3	3	3	3	3	1	
Drop	2,500-2,200								1					
Drop	2,400												1	
Drop	2,500-2,000					2	2	1						
Drop	2,200												1	
Drop	2,000					3	2		5				2	
Drop	2,000-1,600								1					
Drop	2,000-1,500					1								
Drop	1,800								1					
Steam		1	3	3	7	2	5	8	6		2	2	8	
Steam	No. 2 Vulcan	1	2	1			2	2			1	1		
Steam	No. 1 Vulcan				2									

Abstract of Replies on Piles and Pile Driving.

Give the weight of hammer and height of drop and whether you recommend steam or drop hammer for various combinations of the following conditions: (a) water driver, (b) land driver, (c) track driver, (d) soft driving, (e) medium driving, (f) hard driving, (g) foundation piling, (h) trestle piling, (i) sheet piling, (j) timber piling, (k) concrete piling.

As a railroad tool for miscellaneous work, do you prefer a drop or a steam hammer?

Steam hammer	9
Drop hammer	43

A committee of the Superintendents of Bridges and Buildings in 1904 reported in favor of steam hammers for all kinds of pile driving, although their investigation showed comparatively few steam hammers in use on railroad work.

In both of the above investigations the preponderence of replies in favor of drop hammers is undoubtedly due in part to relative unfamiliarity with the actual use of steam hammers.

When do you recommend using rings?

When do you recommend using followers or caps?

Caps.—

For general use	22
Except in soft driving	1

Rings.—

For general use	5
Except in soft driving	12
In hard driving only	12
Total replies	52

Follower.—

If necessary to drive below bottom of leads	18
To drive below ground surface	4
To reduce the amount of cut-off of valuable timber (creosoted)	5
Undesirable, avoid if possible	6
Total replies	33

When do you recommend using shoes?

In one or more of the following: Boulders, rip rap, coarse gravel, shale, slate, hard pan, buried timber, very hard clay	40
In cemented material only	1
To obtain a toe hold in rock, etc	8
Are of little value	4
Never	5
Total replies	58

Have you ever used a water jet? If so, under what conditions?

In sand, quicksand, gravel, etc	40
To loosen piles which are being pulled	3
Have never used a water jet	14
Unsatisfactory in clay	3
Do not approve of use, cannot estimate safe load	1
Total replies	61

Sheet No. 30

Am. Ry. Eng. & M. W. Assn.
Convention of 1909
Com. VII. Wooden Bridges and Trestles.

Unit Stresses for Structural Timber Expressed in Pounds per Square Inch

Recommended by the Committee on Wooden Bridges and Trestles

Kind of Timber	Bending: Extreme Fiber Stress, Average Ultimate	Bending: Extreme Fiber Stress, Safe Stress	Bending: Modulus of Elasticity, Average	Shearing: Parallel to Grain, Average Ultimate	Shearing: Parallel to Grain, Safe Stress	Shearing: Longitudinal Shear in Beams, Average Ultimate	Shearing: Longitudinal Shear in Beams, Safe Stress	Compression: Perpendicular to Grain, Elastic Limit	Compression: Perpendicular to Grain, Safe Stress	Compression: Parallel to Grain, Average Ultimate	Compression: Parallel to Grain, Safe Stress	Compression: For Columns under 15 Diams., Safe Stress	Compression: Formulas for Safe Stress in Long Columns over 15 Diams.	Ratio of Length of Stringer to Depth
Douglas Fir	6100	1200	1,510,000	690	170	270	110	630	310	3600	1200	900	$1200(1-\frac{L}{60D})$	10
Longleaf Pine	6500	1300	1,610,000	720	180	300	120	520	260	3800	1300	980	$1300(1-\frac{L}{60D})$	10
Shortleaf Pine	5600	1100	1,480,000	710	170	330	130	340	170	3400	1100	830	$1100(1-\frac{L}{60D})$	10
White Pine	4400	900	1,130,000	400	100	180	70	290	150	3000	1000	750	$1000(1-\frac{L}{60D})$	10
Spruce	4800	1000	1,310,000	600	150	170	70	370	180	3200	1100	830	$1100(1-\frac{L}{60D})$	—
Norway Pine	4200	800	1,190,000	590	130	250	100	—	150	2600*	800	600	$800(1-\frac{L}{60D})$	—
Tamarack	4000	900	1,220,000	670	170	260	100	—	220	3200*	1000	750	$1000(1-\frac{L}{60D})$	—
Western Hemlock	5800	1100	1,480,000	630	160	270*	100	440	220	3500	1200	900	$1200(1-\frac{L}{60D})$	—
Redwood	5000	900	800,000	300	80	—	—	400	150	3300	900	680	$900(1-\frac{L}{60D})$	—
Bald Cypress	4800	900	1,150,000	500	120	—	—	340	170	3900	1100	830	$1100(1-\frac{L}{60D})$	—
Red Cedar	4200	800	860,000	—	—	—	—	470	230	2800	900	680	$900(1-\frac{L}{60D})$	—
White Oak	5700	1100	1,150,000	840	210	270	110	920	450	3500	1300	980	$1300(1-\frac{L}{60D})$	12

Note:- These unit stresses are for a green condition of timber and are to be used without increasing the live load stresses for impact. *Partially air-dry. L = length in inches. D = least side in inches.

Have you driven "butt down"? If so under what conditions?

Of 52 replies, only 11 had, for such reasons as: In sand or loam, using a water jet; in soft driving; in sand on account of the pulling action of ice; in rock overlaid with mud; when splicing is necessary; for ferry slips; when butts were too large to enter leads; for tests only; when piles were very long and also when rock was close to the surface; in quicksand and also for falsework.

OVERDRIVING PILES.

The most prevalent bad practice in pile driving is overdriving, i. e., injuring the material of a pile by too violent or too continued hammering. When such injury occurs above ground, in the form of brooming or splitting, and can be prevented by the use of rings or caps, it is regarded as an indication of overdriving. The use of such protective appliances as rings, caps, or shoes is a legitimate means for securing the necessary penetration of softwood timber and of even hardwood timber in difficult ground. When, however, the resulting injury occurs below the surface of the ground, and, therefore in that portion of the pile which will be a part of the finished structure, the pile may be said to be overdriven. Injuries of this nature may consist of a slight brooming of the foot of the pile and so be negligible, or they may be of sufficient importance to imperil the stability of the structure.

It is frequently claimed by contractors and their foremen, and with apparent reason, that engineers specify conditions regarding penetration due to the last blows which are too severe. Pile driving can never be an exact science, and the "practical man" seems to have some reasons for his poor opinion of a specification which applies with equal force to every known and unknown condition of the ground. Unfortunately, it is sometimes difficult to distinguish between the action of an overdriven pile and that of a perfectly sound pile in certain ground. Practice in the art and some investigation of the underlying conditions are perhaps the surest guides to success.

In general, overdriving may be due to one or more of the following causes: (1) The use of the word "refusal" in the specifications. (2) A belief in the prevalence of intermediate or floating hard strata. (3) The use of a light hammer and a long drop. (4) Attempting to force aside mythical small boulders. (5) An unnecessary effort to make the pile-driving record suit a formula which was not intended by the proposer thereof to apply to such cases.

It is usually claimed, in cases of overdriving, that no evidence of injury was shown during the driving. This claim is open to considerable doubt, and a more careful examination of the underlying strata should prevent many failures.

A pile passing through soft material and bringing up on rock cannot be driven into the rock. This condition indicates that another type of foundation may be needed. Pile foundations in ground hard enough to broom and split hardwood piles can often be otherwise designed with advantage. Many kinds of ground, easily penetrated under continual driving, develop a skin friction in excess of the probable requirements. Short, quick blows of a heavy hammer produce the best results. A sudden change in the amount of penetration should be considered a suspicious occurrence. Finally, pile driving is a means, not an end, and a whole pile in almost any ground is better than pieces of a pile in good ground.

Appendix D.

This appendix is an abstract of the results of a valuable series of tests of full-size stringers made by Prof. A. N. Talbot of the University of Illinois. Prof. Talbot permitted this publication by the committee in advance of the regular publication of the tests in a bulletin of the Engineering Experiment Station of the University of Illinois. These tests give important new information of the relation of longitudinal shear in beams to direct shear parallel to the grain in short blocks, and an interesting analysis of the influence of defects upon the stresses in the outer fibers as well as on the horizontal shear of the neutral surface.

Conclusions.

The committee recommends the adoption of the following conclusions:

(1) That the Standard Specifications for Bridge and Trestle Timbers be approved as good practice.

(2) That it is preferable to make the inspection of bridge and trestle timbers at the mills.

(3) That the Revised Specifications for Timber Piles be approved.

(4) That the list of Safe Unit Stresses for Structural Timber be approved.

The report is signed by Henry S. Jacoby (Cornell Univ.), Chairman; James Keys (U. P.), Vice-Chairman; F. H. Bainbridge (C. & N. W.), F. E. Bissell (Con. Eng.), A. L. Bowman (Con. Eng.), R. D. Coombs (Penn. T. & T.), William Graham (N. Y., N. H. & H.), Hans Ibsen (M. C.), F. B. Scheetz (Mo. P.), W. F. Steffens (C., C. & O.), B. A. Wood (M. & O.).

The undersigned endorses the report with the exception of the safe unit stresses, which, it is believed, should be reduced 10 per cent, since they are to be used without increasing the live load stresses for impact.

L. J. Hotchkiss (C., B. & Q.)

The undersigned endorses the report, except as to specifications for longleaf yellow pine.

C. C. Wentworth (N. & W.)

Discussion.

Prof. Jacoby: The committee received instructions to hold a conference with the corresponding committees of the Yellow Pine Manufacturers' Association and the American Society for Testing Materials, and I have requested Mr. Bainbridge, who is the chairman of the sub-committee of conference, to make the statement concerning this part of the work.

Mr. Bainbridge (C. & N. W.): The matters to be decided on, on which there was a disagreement, were considered by Committee Q of the American Society for Testing Materials, and the sub-committee of this association. Committee Q allowed dead timber to be used. This was discussed at the meeting of Committee Q, the sub-committee of this association and committee of the Yellow Pine Manufacturers' Association in Chicago last June. On this matter we agreed to give in, on the ground that in the present state of our knowledge dead timber—meaning timber which had been burned over—was good if it was sound. The word "sound" of course covers the timber that is decayed or worm-eaten. Committee Q had specifications regarding wind. At that meeting it was agreed to include the wind. Committee Q allowed sawing ¼ in., scantling size, and that was agreed to. Committee Q permitted loose knots except within 4 in. of the edges of the stringers. Our position forbidding any loose knots was agreed to by all. Committee Q permitted loose knots in corners of posts, which was agreed to. In grade No. 1, Committee Q permits 5 per cent loose heart in stringers. In that respect the entire specification was changed at the request of the Yellow Pine Manufacturers' Association and a specification adopted on the basis of the girth of the stringer. This was for the reason that in a long stringer, on one of the narrow faces there might be a thin sliver of sap running out which would be of no particular objection, could be adzed off, and the stick would be as good as it was before.

After these specifications had been agreed on and the parties began to think it over, each one wanted to change something, so that we are still quite as far from an agreement as we were in the first place. But we have been getting close to the Yellow Pine Manufacturers' Association. The committee had a meeting with a representative of that association last night, and we disagreed in comparatively unimportant matters, in some respects, but the items of difference are these: In the first place they object to our grading and we wish to stick to it. We have No. 1 R. R., and No. 2 R. R. They want to call the first grade "heart," and the other grade No. 1. Then they object to the terms "straight and true," true referring to a uniform cross-section and straight to a straight axis in the stick. We are willing to cut out the "true" on the ground that "standard sawing" covers that close enough, but we wish to retain "straight."

The others was as to "knots" in paragraphs 7, 8, 9, 13 and 14, in which our committee was willing to meet them. Beginning at paragraph 1, the committee would ask that the word "trees" be eliminated, as that word was put in there because we originally had live trees and the matter was overlooked. Then there is an obvious omission in the specification that all parties have agreed to change. Paragraph 4 had in it "all knots shall in no case exceed 4 in. in their largest diameter." That was a specification for the second grade, but overlooked in the first grade. We add it to the first grade. One member of the association, who is very well informed in the matter, is of the opinion that the specifications for fir should be separated from the specifications for yellow pine. That has always been my own idea of the matter, as well, and the committee have all agreed to that.

It is the intention of the committee to ask the approval of these specifications as submitted for yellow pine and withdraw the specifications as far as they refer to Douglas fir, and that the specifications for the latter be left for a following year.

Prof. Jacoby: The first conclusion under No. 1 R. R. Grade will be considered with the Douglas fir cut out entirely.

The secretary read the standard specifications for bridge and trestle timbers.

Prof. Jacoby: In paragraph 4 an addition is to be made as follows: "But knots in no case shall exceed 4 in. in their largest diameter."

C. F. Loweth (C. M. & St. P.): The committee proposes to

drop out all reference to Douglas fir. I suggest that, since the title of the specification is "long-leaf yellow pine," these words be left out of article 4.

The secretary read paragraphs 5, 6 and 7.

Prof. Jacoby: The proposed change is that in paragraph 7, as well as in several others that will follow, after the words "shall be free from" in next to the last line we substitute "any large knots or other defects that will materially injure its strength."

C. P. Howard (L. S. & M. S.): I ask what is the idea in cutting out these figures that give the size of the knots, and describing the objectionable knots as any knot that will impair the strength of the material. We have something here which is definite to go by and it would seem the other way would leave it open to dispute.

Mr. Bainbridge: The matter was contained in our original agreement with the Yellow Pine Manufacturers' Association. They claim there are certain positions in a stick in which almost any knot could be allowed. For instance, you could take the extreme end of a girt and plaster it with knots and it would not do any harm. They felt it was a matter that could well be left to the inspector in cases of certain material. We have met them half way and do not specify the sizes of knots any more and leave the question to be decided according to the new definition.

The secretary read paragraph 1 under "specifications for timber piles."

J. B. Berry (C. R. I. & P.): Does the committee propose to make a specification for timber that is to be creosoted?

Mr. Bainbridge: We thought that matter had better be left in the hands of the special committee looking after the matter of creosoting, to make a report on that.

Prof. Jacoby: It is proposed to eliminate the words "Douglas fir" and "western hemlock" from the title of Grade No. 2.

Conclusion No. 1 was adopted as amended, and conclusion No. 2 was adopted.

The secretary read the revised specifications for timber piles.

J. C. Nelson (S. A.): We should specify more clearly what is meant by cypress. We have a number of different kinds of cypress. Some good and some not good.

Mr. Bainbridge: It was our intention to retain the Douglas fir in the piling.

J. O. Osgood (C. of N. J.): I notice that the specification No. 1 R. R. Grade, does not include chestnut, neither does it include spruce. Spruce is not a suitable timber, as I understand, for working away from the water, but it is used in Eastern waters for a first-class pile. It probably stands as well in docks in New York City as yellow pines and at times is more expensive. Chestnut is used a great deal in the East and makes an excellent pile. It is durable as regards decay, and strong enough for all practical purposes.

Mr. Howard: Is "cypress" intended to include all kinds of cypress? Mr. Nelson said there is a good deal of difference in cypress, red cypress perhaps being all right and others no good at all.

Mr. Nelson: I would move that after the word "and" in the last line of paragraph 1, we make it read "red or black" cypress. Red seems to be the one which is good, and all others bad, but that is not the local understanding in Florida and Louisiana, where most of the cypress comes from. In the Carolinas they have all kinds, yellow, red, white, blue and some black, and even green cypress, and none of it seems to be any good except that which is designated as red or black.

J. P. Snow (B. & M.): I second the motion, and ask if the committee will not insert chestnut in the list of timbers that are specified?

L. A. Downs (I. C.): I amend it to read "red, black or yellow cypress." Nine-tenths of the cypress the Illinois Central uses is yellow cypress and we find it satisfactory indeed. That is the kind we get in Mississippi, and not much else in Louisiana.

The President: The chair suggests that one motion be made to include the cypress change. The committee does not feel they can accept that, but would accept the insertion of chestnut. The motion that paragraph 1 be amended by inserting the words "red, black or yellow" before the word "cypress" is in order.

The motion was lost.

The secretary read paragraph 3.

Mr. Snell: I think that is an impossible specification to have, that a line drawn from the center of the butt to the center of the tip shall lie within the body of the pile. The Lackawanna is trying to buy oak piles under the specification allowing 1 in. clearance, and we have not been able to have orders filled. I believe that should read that the length of the pile shall govern the crook allowed. It should not apply on a 60 ft. stick and 30 ft. stick alike.

Mr. Bainbridge: The question was very carefully considered, and it was considered that more of a crook could be allowed in a short pile, which was heavier, than in a long pile. As a matter of fact, the strength of the long pile is much more essential than that of the short pile. It will get harder driving. This is an old specification, has been here many years. Before including it in the report, I went over 1,000 piles and had a couple of young men go over about 1,000 others that were nothing but second class piles, very cheap, and there were not over 25 or 50 of these piles that would not fulfill the specification. They were maple, Norway, tamarack, red oak, and there was hardly any of them that would not fill the specification, and they were not bought with the intention of filling an original specification.

Mr. Fritch: I move that conclusion 3, relating to the revised specifications for timber piles, be approved as amended.

(Motion carried.)

Prof. Jacoby: There was referred back to the committee last year the question of standard names for structural timbers, and as this matter is directly related to just what has been passed on, the committee reports conclusion 5 and asks that this be taken up at this time. It reads: "That the standard names for structural timbers be approved." They are published in the Proceedings, volume 9, page 358.

The conclusion was adopted.

Prof. Jacoby: I move the adoption of conclusion No. 4, that the list of safe unit stresses for structural timber be approved.

C. F. Loweth (C., M. & St. P.): I think it would be desirable to change the heading in the third column from "safe stresses" to "working stresses." "Safe stresses" would lead to an inference that anything in excess of the stresses indicated might be unsafe.

Prof. Jacoby: The committee will accept that.

When this table is published in the Manual a note should accompany it calling attention to the points which the committee wishes to present in this report, so that they will not be used in a manner different from what was intended. The note reads as follows:

NOTE—The working unit streses given in this table are intended for railroad bridges and trestles. For highway bridges and trestles the unit stresses may be increased 25 per cent. For buildings and similar structures in which the timber is protected from the weather and practically free from impact, the unit stresses may be increased 50 per cent. To compute the deflection if a beam under long continued loading instead of that when the load is first applied, only 50 per cent of the corresponding modulus of elasticity given in the table is to be employed.

The President: The suggestion of Prof. Jacoby will be received for information, and the question now is upon the adoption of this conclusion as amended. (Motion carried.)

WOOD PRESERVATION.

The instructions to the committee were:

1. To cover in general the investigating and reporting on the preservation of wood used for ties and for railroad structures and buildings, confining the work of the committee more particularly to processes, methods and results obtained.

2. To present a recommendation as to outline of work for the committee, with suggestions for classification to be followed.

3. Continue the work done heretofore by the committees on Ties and on Wooden Bridges and Trestles relating to the special subjects of processes and methods of wood preservation.

The sub-committees determined on were as follows: (A) Statistics and economics; (B) preservatives; (C) adaptability of woods and their preparation; (D) treating processes.

[An introductory section explains in detail the reasons for the appointment of these sub-committees.]

Statistics.

Thirty-nine members of this association were selected who were likely to possess information. The committee received 36 answers. These are summarily abstracted in Table 1. This table simply gives information so far obtained. It is not conclusive and will in the future be revised and enlarged.

Preservatives.

It was determined to limit the work this year to coal-tar creosote and chloride of zinc. The chief requisite for a successful coal-tar creosote, i. e., one which shall preserve wood for an indefinite period of time, should be that the oil be com-

posed of compounds which, because of their high-boiling points, will guarantee the greatest possible stability. Taking the oils as they are now manufactured, the endeavor should be to reduce the low-boiling fractions as far as possible, consistent with obtaining an oil which shall be fluid enough at all working temperatures to obtain a thorough and equal penetration throughout the mass of the wood cells. This means that it is found advisable to omit any definite reference to individual compounds in any specification for creosote oil. The correctness of this conclusion is sufficiently demonstrated by the fact that there appears to be no agreement among those who have used creosote oil for a long period of years as to which compound or compounds are to be considered as specifically important in increasing the preservative value of coal-tar creosote. With this end in view the following specification, which was given last year in Appendix F to the report of the Tie

TABLE I.

No.	Name.	Date of Letter.	Road, Etc.	Yr.	Process.	What Treated.	Kind of Wood.	Lbs. per Cu. Foot.	Results.	Mode of Failure.	No.
1	C. H. Ewing...	7-20-08	Phila. & Read.	1851	Kyanizing.....	Track ties.....	Not stat'd	.....	Wood preserved.	Strength reduced	1
1	C. H. Ewing...	7-20-08	Phila. & Read.	1852	Tar Treatment..	Track ties.....	Not stat'd	.....	Not preserved...	Caused dry rot..	1
1	C. H. Ewing...	7-20-08	Phila. & Read.	1867	Burnettizing....	305,107 track ties	Not stat'd	.....	Partly preserved.	Brittle and broke	1
2	W. H. Courtenay.....	6- 2-08	L. & N.....	1876	Creosoting.....	Stringers.....	L. L. Pine	16 lbs....	Sound after 24 yr	Some washed away.....	2
2	W. H. Courtenay.....	6-23-08	L. & N.....	1876	Creosoting.....	50,000 piles.....	L. L. Pine	.....	25 years life.....	Some washed away.....	2
2	W. H. Courtenay.....	6-23-08	L. & N.....	1878	Creosoting.....	15,000 bridge ties	Pine.....	12-18 lbs..	45% to 55% still in 1896.....	Some washed away.....	2
2	W. H. Courtenay.....	6-23-08	PensacolaDock	1882	Creosoting.....	Wharf timber....	Pine.....	16-18 lbs..	Attacked by toredo.....	Some still in use 1908.....	2
2	W. H. Courtenay.....	7-16-08	L. & N.....	1879	Creosoting.....	1893 bridge ties..	Pine.....	20-22 lbs..	533 in June, 1905 28%.....	Rail cut and spike killed....	2
3	J. O. Osgood..	7- 3-08	C. of N. J.....	1876	Creosoting.....	5,000 track ties..	Hemlock .	12 lbs....	Life 15½ years...	Cut by rail.....	3
3	J. O. Osgood..	7- 3-08	C. of N. J.....	1896	Creosoting.....	50,000 track ties .	Y. Pine..	12 lbs....	Life not stated..	Cut by rail.....	3
3	J. O. Osgood..	7- 3-08	C. of N. J.....	1892	Creosoting.....	Piles and timber .	Y. Pine..	.....	Life 20 years....	.....	3
4	J. F. Snow....	7- 7-08	B. & M.....	1884	Kyanizing.....	100,000 ties.....	Hemlock .	Varied....	Life 10-14 years .	Splinter and sliver.....	4
5	E. B. Cushing.	6-21-06	H. & T. C. Ry.	1880	Creosoting.....	150,000 ties.....	Pine.....	10 lbs....	Life 19 years....	11,282 in track in 1906. Railworn	5
6	E. B. Cushing.	10- 1-08	Galveston Bay	1875	Creosoting.....	4,000 piles or more	Pine.....	8 lbs.....	No record of life.	Destroyed by teredo.....	6
6	E. B. Cushing.	10- 1-08	Galveston Bay	1875	Creosoting.....	150 piles or more.	Pine.....	24 lbs....	Life 20 years or more.....	17 lbs. oil per cu. ft. found by Alleman 1904.	6
7	D. K. Colburn.	8-25-08	Texas & N. O.	1888	Burnettizing....	10,500,000 ties...	Pine.....	0.25 lbs....	Life 10-11 years.	Decay.....	7
7	D. K. Colburn.	8-25-08	Texas & N. O.	1888	Creosoting.....	77,500,000 F B M	Pine.....	2½ gal....	For piles, 25 yrs.	Occasional bad treatment.....	7
7	D. K. Colburn.	8-25-08	Texas & N. O.	1888	Creosoting.....	Piles and timber.	Pine.....	1½ gal.....	For timber, 25 years.....	Occasional bad timber.....	7
8	E. O. Faulkner	8-18-08	A. T. & S. F...	1885	Burnettizing....	15,096,561 ties...	Pine.....	.25 to.5 lb.	Life 10.55 years..	10.8 to 14.9 in dry regions....	8
8	E. O. Faulkner	8-18-08	A. T. & S. F...	1906	Rueping.....	2,176,417 ties....	Pine.....	4½ to 5 lb..	Too recent.....	.....	8
9	R. L. Huntley.	7-14-08	Union Pac.....	1886	Zinc-Tannin.....	150,000 ties.....	Hemlock .	0.30 lb....	Life 12-15 years..	Rail worn.....	9
10	O. Chanute....	8- 8-08	C. R. I. & P...	1886	Zinc-Tannin.....	5,641,731 ties....	Hemlock .	.25 to.5 lb.	10¾ years east of Missouri River 11.7 yrs. west.	Decay and rail cutting.	10
11	J. H. Wallace..	6-27-08	So. Pac.....	1889	Creosoting.....	70,000,000 feet... piles and ties..	Pine.....	10 lbs....	Life 20 years....	Few failures.....	11
11	J. H. Wallace..	6-27-08	So. Pac.....	1895	Burnettizing....	12,000,000 ties...	Pine-Fir..	.27 lb....	Life 10-12 years..	Checking and dry rot.....	11
12	R. Angst.....	10-19-06	D. & I. R.....	1891	Zinc-Tannin.....	256 ties.....	Various...	.50 lb....	74% in after 15 years.....	Rail cutting.....	12
13	T. E. Calvert..	7-29-08	C. B. & Q.....	1869	Creosoting (See-ley).....	25,000 ties.....	Hemlock .	1-inch....	Life 5 to 12 years	Dry rot.....	13
13	T. E. Calvert..	7- 8-08	C. B. & Q.....	1899	Burnettizing....	4,836,668 ties....	Pine-Fir..	.35 to .5 lb	Est. life 10-12 yr.	Rot when covered with earth..	13
14	R. H. Howard.	1-31-08	C. & E. I.....	1899	Zinc-Tannin.....	1,929,855 ties....	Oak.....	.50 lb....	Est. life 14 yrs...	See detail.....	14
15A	R. Trimble....	7- 3-08	Penna. Lines...	1896	Zinc-Tannin.....	63,187 ties.....	Various...	.50 lb.....	.....	Decay.....	15A
15B	W. C. Cushing.	7- 6-08	Penna. Lines..	1897	Zinc-Tannin.....	126,973 ties.....	Various...	.50 lb.....	Est. life 12 years.	Decay and rail cutting.....	15B
16	S. B. Fisher...	6-29-08	M. K. & T.....	1901	Zinc-Tannin.....	1,300,612 ties....	Sap pine..	.....	22% out in 6 yrs.	Changed to Burnettizing.....	16
16	S. B. Fisher...	6-29-08	M. K. & T.....	1903	Burnettizing....	1,844,759 ties....	Sap pine..	.....	3.4% out in 4 yr.	Changed to Rueping.....	16
17	A. H. Hogeland	12-16-08	Gr. Nor.....	1901	Zinc-Tannin.....	Cross ties.....	Tamarack -Spruce	.78 lb....	Too recent.....	No failures.....	17
17	A. H. Hogeland	12-16-08	Gr. Nor.....	1904	Burnettizing....	Cross ties.....	Pine-Fir..	.78 lb....	Too recent.....	No failures.....	17
18	E. O. Faulkner	.....	Exper in Texas	....	.....	.....	.....	.....	.....	.....	18
19	J. B. Berry....	11- 9-08	C. R. I. & P...	1886	Zinc-Tannin.....	Cross ties.....	Hemlock .	.50 lb....	11 years life	.....	19
19	J. B. Berry....	11- 9-08	C. R. I. & P...	1907	Creosote.....	Timber and ties.	Gum-Beech	6.80 lbs...	Too recent.....	.....	19
20	G.M.Davidson.	8- 5-08	C. & N. W.....	1903	Burnettizing....	2,184,336 ties.....	Hemlock .	.50 lb....	Too recent.....	.....	20
20	G.M.Davidson.	8- 5-08	C. & N. W.....	1908	Zinc-Creosote....	Ties.....	Various ..	.....	Too recent.....	.....	20
21	C. W. Berry to R. L. Huntley	7-14-08	Union Pac.....	1902	Zinc-Chloride....	Ties.....	Pine-Fir..	.25 lb....	10-12 years life..	See No. 9.....	21
		7-14-08	Union Pac.....	1902	Creosoting.....	Piles.....	Pine-Fir..	.....	.....	.....	21
22	H. R. Safford..	8-22-08	Ill. Central....	1903	Zinc-Chloride....	5,876,173 ties....	Oak and beech...	.50 lb....	8-10 years life est	.....	22
22	H. R. Safford..	8-22-08	Ill. Central....	1903	Creosoting.....	Piles and timber.	Pine.....	14-18 lbs..	25-30 yrs. life est.	Favors Rueping.	22
23	C. F. Loweth..	9- 5-08	C. M. & St. P..	1904	Creosoting.....	Piles and timber.	Pine.....	12-16 lbs..	Too recent.....	.....	23
23	C. F. Loweth..	9- 5-08	C. M. & St. P..	1902	Burnettizing....	Ties.....	Pine.....	.30 lb....	Too recent.....	.....	23
23	C. F. Loweth..	9- 5-08	C. M. & St. P..	1905	Rueping.....	Ties.....	Pine.....	5 lbs.....	Too recent.....	.....	23
24	W. D. Taylor..	11- 5-08	T. St. L. & W..	1905	Burnettizing....	500,000 ties.....	Various..	.50 lb	Too recent.....	.....	24
25	G. W. Boschke	7- 2-08	Ore.Ry.& Nav.	1904	Burnettizing....	Piles, timber, ties	Douglas Fir.....	.25 lb....	Too recent.....	.....	25
25	G. W. Boschke	7- 2-08	Ore.Ry.& Nav.	1906	Creosoting.....	1,395,975 ties 212,006 FBM..	Douglas Fir.....	8-10.....	Too recent.....	Caps weakened..	25
26	A. L. Kuehn...	6-27-08	C.C.C.& St.L..	1904	Zinc-Creosote....	693,324 ties.....	Oak and gum....	.50 lb....	Too recent, est.. 11-12 years...	.....	26
26	A. L. Kuehn...	6-27-08	C.C.C.& St.L..	1904	Lowry Process..	1,650,000 ties....	Oak and gum....	6.3 lbs...	Too recent, est.. 16 years.....	.....	26
27	W. D. Taylor..	8-13-08	C. & A.....	1900	Burnettizing....	450,000 ties.....	Various...	.....	Some decayed in 3 or 4 years..	.....	27
27	W. D. Taylor..	8-13-08	C. & A.....	1900	Creosoting.....	Piles and timber.	Y. Pine..	.....	Good after 8 yrs .	.....	27
28	M. L. Lynch ..	7- 7-08	St. L. & S. W .	1905	Zinc-Creosote....	Ties.....	S. L. Pine.	.24 lb zinc 3 lbs creo	Too recent.....	.....	28
28	M. L. Lynch..	7- 7-08	St. L. & S. W .	1905	Creosoting.....	Piles and timber.	S. L. Pine.	12 lbs....	Too recent.....	.....	28
29	L. Bush.....	7- 9-08	D. L. & W....	1905	Creosoting.....	12,060 bridgeties	Y. Pine..	12 lbs....	Too recent.....	.....	29
29	L. Bush.....	7- 9-08	D. L. & W....	1907	Creosoting.....	8,000 track ties..	Y. Pine..	12 lbs....	Too recent.....	.....	29
30	Wm. McNab....	7-29-08	Grand Trunk..	1903	Burnettizing....	255,574 ties.....	Red Oak .	.....	Too recent,10 yr	.....	30
31	W. L. Darling.	9- 5-08	Nor. Pac.....	1907	Creosoting.....	94,694 ties.....	Various...	7 lbs.....	Too recent.....	.....	31
31	W. L. Darling.	9- 5-08	Nor. Pac.....	1907	Creosoting.....	Timber.....	Various...	15 lbs....	Too recent.....	.....	31
32	J. M. Meridith.	6-29-08	Flor. E. Coast.	1907	Creosoting.....	16,000 ties.....	Pine.....	.....	Too recent.....	.....	32
33	W. H. Moore..	.....	N.Y.N.H.& H.	....	.....	.....	.....	.....	.....	.....	33
34	J. F. Hinckley.	11- 7-08	St. L. & S. F..	1905	Rueping.....	332 ties.....	Red Oak .	5 lbs.....	Too recent.....	.....	34
34	J. F. Hinckley.	11- 7-08	St. L. & S. F..	1906	Rueping.....	1,107 ties.....	R. Oak and gum.	4 lbs.....	Too recent.....	.....	34
35	A. F. Rust....	8-29-08	K. C. Southern	1904	Creosoting.....	.....	Pine.....	12 lbs....	Too recent.....	.....	35
36	E. B. Ashby...	8- 7-08	Lehigh Valley.	1886	Creosoting.....	Piles, timber, ties	Oak and pine...	8-12 lb...	Over double life..	.....	36
37	A. O. Cunningham.....	10-17-08	Wabash.....	1903	Burnettizing....	Ties.....	Red Oak .	.513 lb..	Life 5 to 6 years.	Rail cuts — are brittle.....	37
38	T. E. Calvert..	9-18-08	C. B. & Q.....	1902	Hasselman.....	37,999 ties.....	Pine.....	.....	Dead failure.....	.....	38
38	T. E. Calvert..	9-18-08	C. B. & Q.....	1902	Hasselman.....	15,597 ties	Fir.....	.....	Dead failure.....	.....	38

Summary of Statistical Information on Treated Ties Received from Members.

Committee, is recommended. The principal points in connection with this specification are that it leaves out of consideration the question of relative properties of compounds and dwells essentially upon the necessity of obtaining fractions of a high-boiling character, as determined by fractional distillation:

STANDARD SPECIFICATION FOR COAL-TAR CREOSOTE.

The oil used shall be the best obtainable grade of coal-tar creosote; that is, it must be a pure product of coal-tar distillation and must be free from admixture of oils, other tars or substances foreign to pure coal tar; it must be completely liquid at 38 deg. C., and must be free from suspended matter; the specific gravity of the oil at 38 deg. C. must be at least 1.03. When distilled according to the common method, that is, using an 8 oz. retort, asbestos covered, with standard thermometers, bulb ½ in. above the surface of the oil, the creosote, calculated on the basis of the dry oil, shall give no distillate below 200 deg. C., not more than 5 per cent. below 210 deg. C., not more than 25 per cent. below 235 deg. C., and the residue above 355 deg. C., if it exceeds 5 per cent. in quantity, must be soft. The oil shall not contain more than 3 per cent. water.

SPECIFICATION FOR ZINC-CHLORIDE.

The zinc-chloride used shall be as free from any impurities of any kind as is practicable, being slightly basic and free from free acid.

Methods for Measuring Coal-Tar Creosote.

The committee recommends that the standard temperature at which oil should be stated be 100 deg. F. At this temperature practically all creosote oils in common use are liquid and can therefore be readily measured. In view of the fact that coal-tar creosote is used at temperatures other than 100 deg. F., it is necessary to reduce the volume at any observed temperature to the standard volume at 100 deg. F. The factor which is almost universally in use at the present time for making volume corrections is 1 per cent. expansion or contraction in volume for every 22½ deg.

In making corrections for volume it is exceedingly important to state a volume at a standard temperature as indicating 100 per cent., i. e., a unit volume. If this be taken at 100 deg. F., this will mean that oil at a temperature of 122½ deg. F. will be 101 per cent. of the volume at 100 deg. F.; and oil at 77½ deg. F. will be 99 per cent. of the volume at 100 deg. Bearing this in mind and taking the temperature at 100 deg. as the standard, the following table is submitted to be used in converting the volume at any of the temperatures ordinarily obtained to the standard volume at 100 deg. F.:

Table II.

FACTORS TO BE USED FOR DETERMINING THE VOLUME OF CREOSOTE OIL AT 100 DEGREES F., WHEN THE OIL IS AT TEMPERATURES RANGING BETWEEN 60 TO 225 DEGREES F.

Temp. Fahr.	Factor.	Temp. Fahr.	Factor.	Temp. Fahr.	Temp.	Temp. Fahr.	Factor.
60	0.9822	102	1.0009	144	1.0196	186	1.0382
1	0.9827	3	1.0013	5	1.0200	7	1.0387
2	0.9831	4	1.0018	6	1.0204	8	1.0391
3	0.9836	5	1.0022	7	1.0209	9	1.0396
4	0.9840	6	1.0027	8	1.0213	190	1.0400
5	0.9845	7	1.0031	9	1.0218	1	1.0404
6	0.9849	8	1.0036	150	1.0222	2	1.0409
7	0.9853	9	1.0040	1	1.0227	3	1.0413
8	0.9858	110	1.0045	2	1.0231	4	1.0418
9	0.9862	1	1.0049	3	1.0236	5	1.0422
70	0.9867	2	1.0053	4	1.0240	6	1.0427
1	0.9871	3	1.0058	5	1.0245	7	1.0431
2	0.9876	4	1.0062	6	1.0249	8	1.0436
3	0.9880	5	1.0067	7	1.0253	9	1.0440
4	0.9885	6	1.0071	8	1.0258	200	1.0445
5	0.9889	7	1.0076	9	1.0262	1	1.0449
6	0.9894	8	1.0080	160	1.0267	2	1.0453
7	0.9898	9	1.0085	1	1.0271	3	1.0458
8	0.9902	120	1.0089	2	1.0276	4	1.0462
9	0.9907	1	1.0094	3	1.0280	5	1.0467
80	0.9911	2	1.0098	4	1.0285	6	1.0471
1	0.9916	3	1.0102	5	1.0289	7	1.0476
2	0.9920	4	1.0107	6	1.0294	8	1.0480
3	0.9925	5	1.0111	7	1.0298	9	1.0485
4	0.9929	6	1.0116	8	1.0302	210	1.0489
5	0.9934	7	1.0120	9	1.0307	1	1.0494
6	0.9938	8	1.0125	170	1.0311	2	1.0498
7	0.9943	9	1.0129	1	1.0316	3	1.0502
8	0.9947	130	1.0134	2	1.0320	4	1.0507
9	0.9951	1	1.0138	3	1.0325	5	1.0511
90	0.9956	2	1.0143	4	1.0329	6	1.0516
1	0.9960	3	1.0147	5	1.0334	7	1.0520
2	0.9965	4	1.0151	6	1.0338	8	1.0525
3	0.9969	5	1.0156	7	1.0343	9	1.0529
4	0.9974	6	1.0160	8	1.0347	220	1.0533
5	0.9978	7	1.0165	9	1.0351	1	1.0538
6	0.9983	8	1.0169	180	1.0355	2	1.0542
7	0.9987	9	1.0174	1	1.0360	3	1.0547
8	0.9992	140	1.0178	2	1.0365	4	1.0551
9	0.9996	1	1.0183	3	1.0369	5	1.0556
100	1.0000	2	1.0187	4	1.0373	.....	.....
1	1.0004	3	1.0192	5	1.0378	.....	.....

Explanation—To determine the volume at 100 degrees Fahrenheit, divide the volume at any temperature by the factor corresponding to that temperature in the above table.

MEASUREMENT BY WEIGHT.

The measurement of creosote by volume is always subject to more or less variation, owing to errors obtained in measuring large quantities, and in converting volumes as measured at a given temperature to the standard at 100 deg. F. It is suggested, therefore, that wherever possible oil quantities be measured by weight. If desired, the volume can then be determined by ascertaining the specific gravity.

Adaptability of Woods.

The committee limited itself in the work on the adaptability of woods and their preparation to the grouping of species and the strength of treated timber.

(1) Grouping of Species; (a) controlling factors; (b) wood structure; [H. D. Tiemann, of Yale University, has prepared a clear statement of the elements of wood structure that affect this problem, which is published in full as an appendix.]. (c) present practice. [A circular letter was sent to treating plants, railroad engineers and others likely to have had experience in grouping species of timber for treatment under practical conditions and the results have been abstracted in Appendix D].

(2) Strength of Treated Timber: An examination of all available records of tests of treated timber, published and unpublished, has been made and the nature of the experiments and the conclusions abstracted. The abstract of the data will be published in a later Bulletin. In addition the committee arranged a series of tests, which were being carried on at the time the report was written.

GROUPING OF SPECIES.

The various species, and, indeed, any one species, in its differing conditions of seasoning and habit of growth take treatment unequally when exposed to given retort conditions. For example, dry sapwood of the pines treats easily, but the heart is mainly impenetrable to creosote. Some dry red oak sticks take creosote in certain processes clear through the heart, while beech under the same conditions is very refractory. It is evident that if two woods like red oak and hickory, or loblolly pine and longleaf pine, or heart loblolly and sap loblolly, are placed in the same charge and the average absorption secured, one class will be over-treated and the other under-treated. Interests of economy and proper preservation demand that the various species should be segregated into different groups.

It might seem at first that a suitable grouping could be predicated upon the known structural characteristics of the various species. The arrangement and means of communication between wood cells, the contents of these cells, the size and arrangement of pores and ducts are known and some of the laws of molecular physics controlling the movement of solutions are understood.

The various factors that enter into the problem may be listed as follows: (a) Condition of timber with respect to seasoning; (b) proportion of heartwood or of sapwood; (c) characteristic micro-structure; (d) per cent. of summer wood and spring wood and position in trunk, if readily distinguishable; (e) geographical location of species, elevation, soil and other site conditions as affecting (a), (b) and (c), if ascertained; (f) mutual interaction between the various species when treated in the same cylinder.

It might seem that the experience of treating plants would furnish satisfactory empirical rules for grouping applicable to the treating process used. However, most plants have treated but few species and there seems to have been but little detailed and careful examination of the actual results of the cylinder process upon individual sticks. Conflicting reports are made as to the ease of treatment of a given species, as, for instance, ash and white pine. These are due in part to a confusion of species, or a difference of species grown under different site conditions or latitude.

It appears in general that:

(1) In practice the southern pines are separated on the basis of amount of sapwood.

(2) That green and seasoned timbers are treated separately.

(3) That Douglas fir requires separate and special treatment.

(4) That there is no well-authorized grouping of the various hardwoods, and that this should be a matter of further study.

STRENGTH OF TREATED TIMBER.

As stated, the committee has in progress a series of tests of treated timber which are not yet (November 30, 1908)

complete. The committee presented a compilation of available reports on strength of treated timber. These include: (1) Tests on creosoted and untreated Douglas fir beams made by the Southern Pacific Creosoting Company at Sacramento, Cal., July, 1895, and May, 1906. (2) Tests of creosoted, burnettized and untreated Douglas fir beams made at the University of California in April, 1898. (3) Circular 39, Forest Service, "Experiments on the Strength of Treated Timber." (4) Bulletin No. 18, University of Illinois Engineering Experiment Station, R. I. Webber, "Holding Power of Railroad Spikes." (5) Circular 46, Forest Service, "Holding Force of Railroad Spikes in Wooden Ties." (6) Thesis by F. E. Osborne, School of Civil Engineering, Purdue University, 1901, "Effect of Preservatives on the Strength of Treated Timber." (7) Tests of creosoted Southern pine bridge stringers by the Forest Service at Purdue University, 1908. (8) The tests of Douglas fir bridge stringers treated by the boiling process at Seattle, tested by Forest Service at University of Washington, Seattle. (9) Tests on creosoted ties by Prof. A. N. Talbot, of the University of Illinois.

Experiments are under way at Purdue University for the committee to determine the comparative resistance of railway ties, natural and treated, to the action of the rail.

Treating Processes.

It was concluded to present general matter bringing out general principles observed in the application of wood preservatives. The discussion may be subdivided as follows:

(1) Pressure process.
  (a) Full cell; (b) empty or partly filled cell.
(2) Open tank process.

GENERAL PRINCIPLES TO BE OBSERVED IN APPLYING PRESERVATIVES.

Certain essentials must be observed to make the application of preservatives successful. First: The timber must be seasoned. It must be known to be of such character that it can be treated in the manner prescribed. Second: The element of heat is vital. Temperatures of the process must not be such as to be injurious to the wood. They must also be such that no change or injury will occur to the preservative itself. It is vital, however, that the temperature of treating be as high as possible, because this will either increase the fluidity of the preservative or tend to open the wood cells, or both. The maximum limiting temperature, however, is about 225 deg. F. It is essential in order to produce economical results in the cost of treatment that tanks, retorts or reservoirs, or whatever the vessel in which the timber is treated, be provided with sufficient means of heating, so that the heating may be done quickly and may be easily and surely controlled. Third: In order that there may be minimum cost of application it is necessary to have proper speed of treatment. This involves the entire design of the apparatus for the application. It must be possible to perform every step quickly and accurately, but at the same time thoroughly. Fourth: It must be possible to apply the preservatives uniformly to all pieces of timber in any one charge; that is, each particular piece must have its full quota; this, too, means that the timber in any one charge must be alike in character so far as its ability to absorb is concerned.

THE PRESSURE PROCESS.

The essentials of the apparatus of the process are the sealed retort and the pressure pump. The particular things which govern the apparatus are: (1) The character of the timber to be treated. (2) The character and amount of the preservatives used and the desired methods of application. (3) The desired capacity per day or per hour.

The pressure which must be maintained and the pressure which is the economical one depends on all the four essentials enumerated under the head of "general principles to be observed in applying preservatives." For refractory woods and heavy preservatives, as creosote, it must be possible to produce a pressure of 175 lbs. per sq. in. to obtain economic speed of treatment. For light wood a pressure of 75 lbs. per sq. in. may be ample. These pressures, 175 lbs. per sq. in. and 75 lbs. per sq. in., are in general the upper and lower limits used. If the timber to be treated is limited entirely to refractory woods as the red oaks, it must be possible to obtain the pressure of 175 lbs. per sq. in. When only light woods, as sap pine, are used, a pressure of 75 lbs. per sq. in. may suffice, as stated.

The more fluid a preservative the more easily it can be injected and the lower will be the desirable pressures. High fluidity is valuable. The higher the amount of preservative to be used per unit of timber, the greater will be the necessary pressure.

The desired capacity determines volumes and size of apparatus. A plant which will serve general requirements of the larger railroads will have a capacity of about 1,000 cu. ft. of timber per hour.

In the specifications for treatment adopted by the association it is proposed to steam the ties unless they are thoroughly air seasoned, in which case it may be omitted, at the option of the purchaser. It is to be emphasized, however, that this scheme should at all times be omitted when the ties are thoroughly air seasoned and are to be treated with oils.

It is to be emphasized that in the pressure process it is vital that the sealed vessel or retort must be provided with accurate measuring devices both for measuring volumes and temperatures. It must be possible to determine closely the actions within the retort.

OPEN TANK PROCESS.

The open tank process is the simplest form for applying a preservative. As its name indicates, it consists in dipping the wood in open tanks or vessels filled with the preservative to be used. It necessarily follows that this is an absorption, rather than an injection, of the preserving fluid. It also follows that the depth of penetration obtained is small, except for particularly open or porous woods, such as sap pine, where a penetration of 1½ in. has been obtained.

Recommendations for Future Work.

The necessity for accurate records of results in American practice is urgent in order to furnish sound facts on which to base conclusions. It is found that the value of many experiments in the use of preserved timber has not been productive of knowledge to any proper extent, because of improper records. The committee should go into this matter thoroughly and report on it next year. It should continue the gathering of statistics, co-operating with the Tie Committee and other committees in the gathering of statistics. This co-operation is necessary to avoid duplications. The Forest Service of the Government is doing considerable work on wood preservation and the committee should make free use of this source of information. Statistics to be gathered in the future should be added on the report given in Table I, enlarging and extending it.

It has been found that coal-tar creosote and chloride of zinc will preserve timber when used under the proper conditions and when the proper quantity and quality of preservatives are used. The determination of the conditions should constitute a part of the committee's work together with work on other preservatives. Crude petroleum is at present being used to such an extent that work in this direction is warranted.

The necessity of work upon an improved rail fastening in connection with the use of treated ties is so urgent that the work should be assigned to either this committee or some other for definite report. It is evident from present results that economic life of treated ties cannot be obtained without an improved rail fastening.

The committee should continue work in the determination of proper grouping of timber, working toward the end that some proper grouping may be determined upon. The preparation of the timber for treatment—seasoning, in other words—needs consideration. Some very serious questions in the deterioration of timber while undergoing seasoning now confront railroads which have adopted tie treatment. The proper handling of ties and timber prior to the injection of preservatives should have immediate attention. There is found to be no sound knowledge as yet on the effect of treatments on the strength of timber. As stated, the committee has experiments under way which will be of value in determining this question. These experiments should without question be continued and if possible enlarged.

Appendices.

Appendix A records the experience on the Louisville & Nashville R. R. with creosoted piles and timber.

Appendix B is a list of precautions to be observed in burnettizing ties, prepared by O. Chanute.

Appendix C is an article on the microscopical structure and physical condition of wood as affects penetration by preservatives, prepared by H. D. Tiemann, of the Yale Forest School.

Appendix D gives abstracts of replies received by the committee to its circular letter regarding practice in grouping species. These are summarized in a table included in the appendix.

Conclusions.

(1) Coal-tar creosote and zinc chloride are efficient preservatives when properly applied and when used under proper conditions,

(2) It is necessary to keep better records than have been kept so far in order to form proper conclusions as to the merit of different methods and processes.

(3) Preserved wood may be destroyed by mechanical action long before it is decayed.

(4) The specification as given for coal-tar creosote is good practice and should be adopted.

(5) There should be a standard temperature at which coal-tar creosote is measured. The temperature of 100 deg. F. as given in the report is recommended.

(6) It is essential that timber should be properly grouped in order that a successful treatment may be obtained. The species, proportion of heartwood and sapwood, condition of the timber with respect to its moisture content, and the wood structure, will in general determine this grouping.

(7) It is desirable to air-season timber in order to prepare it for treatment. Most woods can be best treated after being air-seasoned.

The report is signed by A. L. Kuehn, (Amer. Creo. Co.), Chairman; Carl G. Crawford, (Amer. Creo. Co.), Vice-Chairman; R. N. Begien, (B. & Q.); Lincoln Bush, (Cons. Engr.); T. E. Calvert, (C., B. & Q.); O. Chanute, (Cons. Engr.); C. K. Conard, (Erie); W. H. Courtenay, (L. & N.); W. W. Curtis, (Cons. Engr.); E. B. Cushing, (S. P.); Geo. M. Davidson, (C. & N. W.); E. O. Faulkner, (A., T. & S. F.); W. K. Hatt, (Purdue Univ.); V. K. Hendricks, (St. L. & S. F.); S. M. Rowe, (Cons. Engr.); Earl Stimson, (B. & O.); Hermann von Schrenk, (R. I.-Frisco).

Discussion.

Mr. Kuehn: The report is intended to be an introduction of the subject, rather than an exhaustive investigation. A full, conclusive statement of results obtained on a large scale in America will require a number of years. It will be the work of several years, more so, perhaps, than the reports of other committees.

The conclusions were read in order.

Mr. Curtis: I want to call attention to one feature in connection with the specification for coal-tar creosote, as referred to in conclusion 4. I regard the specification as one which, if adopted and live up to, would give us a better article of creosote than we have generally had in past years. But practically all of the oil upon which we are basing our conclusions of the efficiency of creosoted material today are based upon material which would not meet the proposed specifications. They would bar nearly all the oil made in this country and in Great Britain, although the German oil would comply with them. Also, we are confronted, and have been for the last five years, with the difficulty not only of getting the oil which we might want, but of getting any oil at all.

The secretary of the association some months ago sent out a circular to nearly all of the timber treating plants in this country, which were using oil. The specification was given in that circular. Of about 20 replies there are three instances where the reply was that none of the oil which they had been using would be excluded under this specification. Of the other replies, five replied that all the oil they had been using would be excluded. Two reported that all of the oil they had had during the two preceding years would be covered by this specification. The others gave various figures as the proportions that would be excluded, in most cases the amount being over 50 per cent.

I wrote to a number, I think all, of the manufacturing plants in this country where this creosoted oil is made, asking them what percentage of their oil would be eliminated by this specification. I did not receive a single reply. That may be either they are perfectly willing to comply with this specification, or they do not care what we specify and think we have to take their oil. I am sure that this specification, if adopted, will give us a better oil but I doubt the wisdom at present of adopting a specification which will rule out so much oil and which will also rule out a considerable part of the British oil, in view of the shortness of the supply.

The association already has adopted a specification for zinc chloride, which, in my judgment, is a much better specification than the one in the present report. I think the new specification for zinc chloride is worthless as printed.

Mr. Kuehn: I will answer for the remainder of the committee why they voted to adopt the specifications for coal-tar creosote. The supply of creosote oil, being a by-product, is dependent entirely on the demand for pitch. The demand for pitch in this country is limited to roofing, caulking purposes, etc. The demand for creosote oil in America is much in excess of the production. Only about 30 per cent of the creosote oil used in the United States is produced here, the rest is imported. There is a demand for pitch in foreign countries greater than there is in the United States; one demand is for coal briquettes. This foreign demand for pitch produces an over production of creosote oil abroad. Since the demand here exceeds the supply, the manufacturers tell us to take what we can get. But we cannot afford to take everything that is produced and spend money and time in attempting to bring about a long life timber. We can get more oil in England to back up the oil that is being cut out in this country, and we can get such oil as was used 75 years ago, to make timbers last from 35 to 40 years. The association, in adopting that specification, is adopting a specification which is not rigid, not as rigid as it eventually will be, when we treat all of our timber with creosote, and we want to get now as good creosote oil as can be obtained—we do not want to take too many chances. I do not think there will be any mistake made in adopting this comparatively lenient specification.

A. L. Kammerer (Rock Island): Mr. Curtis said that of the plants replying to the circular, only three said their oil would fall completely within these specifications. It seems to me that it would be much fairer, instead of saying three of the total number, to express it in terms of gallons. These three particular plants he mentions represent almost one-half of the total oil consumption of this country. The roads that I am connected with—Rock Island, Frisco, C. & E. I. and Santa Fe—have no great difficulty in getting their supply of oil under specifications practically the same as this one. These four railways consume, annually, about 20,000,000 gallons, representing a large proportion of the oil consumption of this country. Messrs. Von Shrenk, Fulls and myself in our laboratory at St. Louis have conducted extensive experiments to ascertain whether or not these low boiling constituents remain in the treated timber after exposure. We have examined a great number of creosoted specimens both in this country and in Europe which have given service 25 years or more. The analysis of all the oil extracted from these samples shows a total absence of the low boiling constituent, and a natural conclusion is that the long life of these old timbers is due to the presence of the very high boiling constituents of the original oil which are at present found in them.

About two years ago we took an oil having the following analysis:

Specific gravity at 38 degrees C.	1.045
Fractions distilling below 210 to 235 degrees	23.3
Fractions distilling below 235 to 270 degrees	24.1
Fractions distilling below 270 to 315 degrees	17.5
Fractions distilling below 315 to 355 degrees	17.1
Residue	15.5

A considerable portion of this oil was exposed in a vessel in the open air. After one year, it was found that 41½ per cent had disappeared, 90 per cent of which was the portion boiling below 235 degrees. Several ties were treated with this same oil and exposed to the weather for one year. The oil remaining was extracted and examined, with the result that 25 per cent was found to have disappeared. At the same time we conducted another experiment to determine the disappearance of the low boiling oil.

The American Telegraph & Telephone Co. removed five telegraph poles from its lines in the neighborhood of Norfolk, Va., and sent them to our laboratories. These poles were treated and placed in position in 1897. They had been in service about nine years when we examined them. The original oil with which they were treated was an oil very high in low boiling constituents. It had 50 per cent boiling below 235 degrees. Our examination of the oil extracted from these poles showed that 57.1 per cent had disappeared from the tops and 35.5 from the butts.

These experiments conclusively prove that nearly all of the low boiling oil is used in the treatment of timbers, and a very large per cent of the portion boiling below 270 degrees, disappears. The present specification was drawn up having these facts in mind. While it may appear somewhat rigid and American manufacturers may claim that they cannot live up to it, there is no doubt that with a little pressure the present American product can be made to closely approximate the requirements of this specification.

Mr. Curtis: I have no objection to the specification whatever as submitted. I see the possibility of some commercial difficulty for you if it is adopted. I hope to see that specification ultimately adopted. My judgment is it is not wise to adopt it this year.

It was moved and seconded that the specification as reported by the committee be adopted.

The point was then raised in connection with these percentages that the kind of apparatus used in making the tests or analyses should be defined, results differing with 8-oz. retorts, Hemphill tubes or three-bulb tubes, as well as the method of conducting the test. It was also suggested that the specifications should be increased to read that not more than 30 per cent, instead of 25 per cent, distillate will be given off below 235 degrees centigrade.

E. H. Bowser (I. C.): In most oil we do not get a distillation of more than 35 per cent, more often it comes several degrees under. In the older specifications for oil, it is almost invariably the custom to allow 45 per cent of naptha. That would mean 50 to 55 per cent of distillation of 235. The L. & N. specifications at one time allowed as much as 35 per cent. I move that the specifications be changed to read 30 per cent of oil distillate up to 235 degrees centigrade, instead of 25 per cent.

Mr. Fritch: I would like to ask the committee how much difference in price this would make in the cost of creosote oil?

Mr. Kuehn: I am not able to answer that absolutely, but I am of the firm belief it will not make any difference.

The motion by Mr. Bowser was lost.

The specification as given in the report was adopted.

The conclusions of the committee as a whole were adopted.

RECORDS, REPORTS AND ACCOUNTS.

The committee was assigned the following work:

(1) Revise the Track Chart (form M. W. 1016) so that the chart will show the conventional signs as adopted by the association.

(2) Recommends any desirable changes in the conventional signs heretofore adopted.

(3) Review the subject of Time Books and consider a revision of form M. W. 1008, with a view to preparing a form that may be uniformly used by all maintenance of way departments, offering a check against irregular practices, and allowing the use of a daily time report.

(4) Recommends forms for use of the maintenance of way department for preparing detailed estimates of contemplated construction work, this form to be used preliminary to and form the basis for the summary estimate data embodied in forms M. W. 1017, 1018 and 1019.

In addition the committee makes definite recommendations as to the use of single or double lines of track maps.

The organization for sub-committee work was as follows:

(A) Conventional Signs; Track Chart; Single or Double Lines.

(B) Time-Books.

(C) Estimate Forms.

Conventional Signs, Etc.

Instructions given this sub-committee were:

(1) To discuss with the sub-committee of the committee on Signaling and Interlocking the subject of conventional signs indicating signals and features in connection therewith, with a view to harmonizing the symbols recommended in the conventional signs (forms M. W. 1020 and 1021), with the symbols used by the Signaling and Interlocking committee in their work.

(2) Review the whole subject of conventional signs after agreeing with the Signaling and Interlocking committee to determine what, if any, changes should be recommended in forms M. W. 1020 and 1021, adopted by the association in 1907.

(3) Amend the track chart, form M. W. 1016, so that it will conform to the conventional signs heretofore adopted and revised by the committee.

(4) Call for a free expression of opinion of the membership with regard to the use of single or double lines on track maps and formulate a definite recommendation therefor.

SIGNAL FEATURES.

An agreement was reached with the Signaling and Interlocking committee covering the indications for the following signal features: Battery box; train-order signal; home automatic block signal; distant automatic block signal; home interlocking signal; distant interlocking signal; home disk signal; distant disk signal; signal bridge; interlocked switch; interlocking tower; automatic bell; derail.

The joint committee recommended changing the symbols for train-order signal, automatic bell, and derail.

Additions are recommended to the conventional signs to cover: Battery box; automatic block signal; home interlocking signal; distant interlocking signal; distant disk signal.

CHANGES RECOMMENDED IN CONVENTIONAL SIGNS.

The committee discussed the whole subject of conventional signs, and recommended 29 changes, the reasons for which are given in detail.

RECOMMENDED ADDITIONS TO LIST OF CONVENTIONAL SIGNS.

The committee recommends the adoption of symbols to indicate common drain tile, concrete pipe, ground wire conduit, track pans and tunnels.

TRACK CHART.

In 1905 the association adopted a track chart, but this adoption was provisional in character, depending on the conventional signs which were to be considered and recommended afterward.

The track chart, as revised by the committee, includes some additional symbols, as well as some changes, the principal features of which are as follows:

(1) The scales have been enlarged to 1 in. = 4,000 ft. for horizontal and 1 in. = 120 ft. for vertical scale, the reason for this being that it was found that this horizontal scale enabled more information of value to be shown in a much clearer manner, and this vertical scale minimized the breaks in the continuous line of the grade.

(2) Space has been allotted to show the weight of and date when rail was laid and the kind of ballast used in the main track; and in connection with this an alternative color scheme is proposed to be used, where it is desired, to more readily indicate the character of rail in the main track.

(3) The symbols for signals have been changed so as to conform to the revised conventional signs (form M. W. 1025), it being assumed that it is not necessary to show any more details in the way of signal features on the track chart than provided for by the conventional signs.

(4) The section post symbol has been revised to agree with the one shown in the list of conventional signs.

(5) A symbol for water column has been added.

(6) A symbol for water tank has been added.

(7) The symbols for bridges and culverts have been omitted and in lieu thereof a brief description of the structure is to be given

(8) Ruling gradients are indicated by an extra thickness of line.

(9) Special symbols are used to indicate fuel stations, roundhouses, turntables, section headquarters, telegraph offices, etc., the idea being to use a symbol that would more readily indicate to the operating man the location of these important features.

USE OF SINGLE OR DOUBLE LINES.

A circular was sent out with the following questions:

(1) Is it your opinion that double lines should be used exclusively on maps of a scale of 1 in. = 50 ft. or less?

(2) Is it your opinion that single lines should be used exclusively on maps of 1 in. = 200 ft. or more?

(3) (a) On maps of a scale of 1 in. = 100 ft., representing preliminary studies and designs for proposed track layouts, should tracks be represented by single lines?

(b) On maps, of a scale of 1 in. = 100 ft., of completed work, station plats and permanent records, should tracks be represented by double lines?

The replies indicate that the members are strongly in favor of the committee's recommendations on questions 1, 2 and 3-a, but are not quite so harmonious in regard to No. 3-b.

The following advantages are claimed by those who advocate the use of single lines on record maps:

(1) Single lines are more easily drawn by the average draftsman, thus saving time and expense.

(2) Single lines show actual location of center line of track as staked out by the engineer.

(3) Lateral distance is more easily and clearly indicated.

(4) Single line representation of tracks is less confusing to the eye.

The following advantages are claimed by those who advocate the use of double lines:

(1) Double lines show actual location of rails, single lines show imaginary center lines. The fundamental idea of a track plan is to show the physical conditions as they exist on the ground, and a double line drawing is the only way in which this can be done.

(2) Turnouts clearly indicated and location of frogs, derails, crossings, clearance points, etc., accurately shown.

(3) Track plans for interlocking and signal work are always made with double lines.

(4) It is very difficult for a young draftsman to learn the proper method of handling switch work by single line method.

(5) Double line representation is easiest for construction men. The more complicated the layout the more clearly is it shown by double lines and more easily comprehended by the field men.

TIME BOOKS.

Inquiries showed that an exceedingly small percentage of the membership use the time book adopted by the association. The committee believes this book deficient in the matter of distribution, where the daily time report is not used. It therefore recommends the adoption of two forms of time books, one to be used where it is practicable to use the daily time report, and the other where this is impracticable. For the first form the committee recommends the use of form M. W. 1008 with the addition of two columns, the purpose of which is indicated, and for the second the committee proposes a book which is exhibited in detail and which is in two forms, one for the track department and the other for the distribution of time of structural gangs, with a page for each man.

The committee recommends the adoption of a daily form for reporting time, believing it will be of great value in helping to a more prompt compilation of accounts and in enabling supervising officers to keep in close touch with expenditures and guard against irregular practice. The committee recommends as an adjunct to the daily time report, a sheet representing a compilation of the information shown on the daily report, this sheet to be kept in the office of the supervising officer or of the accountant.

Estimate Forms.

It is the opinion of the committee that much good can result from the adoption of a uniform method of preparing estimates. Too often such estimates are prepared according to the notions of the individual engineer, and in many instances a failure to have before him in printed form the items that are usually found in work of that character causes him to make omissions. It is, of course, understood that there cannot be a form which would be uniformly applicable to all of the branches of the maintenance of way department, and consideration should be given to the preparation of forms for the following work:

(1) Bridge work, including trestles, pipes or masonry. (2) Building work. (3) Water service. (4) Signal and interlocking work. (5) Telegraph lines. (6) Track work. (7) Scale work.

Circulars were sent to the members and replies were quite full and complete, 85 per cent. recommending the use of printed forms. The committee submits with this report a form for estimates ordinarily handled by the engineer maintenance of way for track work. This form includes a number of items that are not purely track work, because they are items that are frequently incidental to the preparation of track estimates.

Conclusions.

(1) The committee recommends the adoption of the revised list of conventional signs.

(2) The committee recommends the adoption of form M. W. 1016 as revised.

(3) On track maps drawn to a scale of 1 in. equals 50 ft. or less, tracks should be represented exclusively by double lines.

(4) On track maps drawn to a scale of 1 in. equals 200 ft. or more, tracks should be represented exclusively by single lines.

(5) On track maps drawn to a scale of 1 in. equals 100 ft.

(a) On maps representing preliminary studies and designs of proposed track layouts, tracks should be represented by single lines, except that double lines may be used where considered necessary to show turnout details.

(b) On maps representing completed work, station plats and permanent records, tracks should be represented by double lines.

(6) The use of form M. W. 1008, with the additional columns as shown for reporting time where it is practicable to use a daily time report.

(7) A change in the cover page of form M. W. 1008 to permit the signature of the foreman and his supervising officer.

(8) The use, wherever possible, of a daily time report for all departments.

(9) The use of the form recommended for time book where the daily report is not used. (Forms M. W. 1109 and 1110.)

(10) The use of the form to represent a compilation of the record and distribution of time. (Form M. W. 1111.)

(11) The use of a system of time checking to guard against errors and fraud.

The report is signed by H. R. Safford (I. C.), Chairman; William Archer (B. & O. S.W.), Vice-Chairman; A. L. Davis (I. C.), Edward Gray (Sou.), E. E. Hanna (Mo. P.), Paul Jones (C. & M. V.), Henry Lehn (N. Y. C.), J. H. Milburn (B. & O.), J. W. Orrock (C. P. R.), H. J. Pfeifer (St. L. Term.), C. W. Pifer (I. C.), V. D. Simar (D., S. S. & A.), J. E. Turk (P. & R.), R. W. Willis (C., B. & Q.).

Discussion.

Mr. Safford: I would suggest a discussion of the subject of the track chart, and briefly I would say the work of the committee this year in connection with the conventional signs was an attempt to make some of the signs more consistent with the subject they represented and to attempt to group them in some systematic order. A few new signs have been added, and some material changes were made in the signal indications which were recommended after the discussion of the report of the Signal committee. That committee agreed as to the signs shown in our list. Of course we do not attempt to show all the signal details. We only considered those things which would be ordinarily used.

The secretary read conclusion 1, in regard to conventional signs, which was adopted.

The secretary read the conclusions with reference to track maps, which were adopted.

Mr. Safford: I move the adoption of the track chart, Form 1016.

Mr. Ferriday (Big Four): I was in some doubts as to what was meant by section house. I find it means section dwelling. I suggest that the explanation of house be changed to "dwelling."

The President: The committee will accept that suggestion.

Mr. Lindsay: The committee shows a line to indicate the alinement. When a curve is below that line, does that mean the curve to the right, or the curve to the left, or is that the actual picture of the curve and the way it would look on the ground? It seems to me the picture should be made as if the curve was hinged at the ends, and the line simply straightened out, so that the direction of the curve actually showed as it would lie on the ground.

Mr. Safford: The reason the committee used that communication was to show exactly the location of the curve, that is, the center. The curvature on the chart shows the relative position of the curvature of the rail.

Mr. Hanna (Mo. P.): In order to make this matter perfectly clear, I move that under the head of "Explanation" a small diagram with this alinement be placed with a note.

Mr. Safford: That is acceptable.

Mr. C. P. Howard: There is no sign for the freight station.

Mr. Safford: I presume that is because there did not happen to be a separate freight station in the territory from which this chart was made. That should be shown the same as the passenger station. I move the adoption of the form of track chart as submitted.

(The motion was carried.)

The President: We will now take up time books.

Mr. Safford: I move the adoption of the forms of time books indicated as M. W., 1008, 1109 and 1110.

Mr. Ewing: I should say it would be a little clearer if we would leave out the word "daily" on form 1008 and make it "record of time for the month of ——."

The President: The committee accepts the suggestion of Mr. Ewing. The question now is upon the adoption of these forms, with that amendment.

The forms were adopted.

The President: Now the estimate form will be considered.

Mr. Gray (Sou.): This form was gotten up with the idea of covering, to as great an extent as possible, all of the different items which would be used in the construction of track and in roadway material, including railroad crossings, grading, ballasting, etc. The list covers nearly everything that is used in construction and maintenance work, the purpose of which is to assist the memory of the estimator or the compiler.

Mr. Lindsay: This is a very valuable form, and we could probably use it, but we would require additional columns on the right hand side of the page in which to show divisions of cost—for instance between the railroad company and a private individual or between two railroad companies. I think the blank could be approved if it provided additional space for such purposes.

Mr. Safford: That can be very easily added to this form if it is acceptable to the association. I wanted to make it clear that we propose to prepare additional forms for bridge work, signals, etc. I move that the association adopt this form with the amendment proposed by Mr. Lindsay.

A. Montzheimer: It seems to me the blank ought to show what a turnout consists of, and that it doesn't include rail between the split switch and the frog. That has been a source of trouble to us.

Mr. Safford: Wouldn't that be in the nature of a detail that could be used in the preparation of any estimate? All the items that go to make a turnout are contained here and it would be pretty hard to omit any of them if you followed the design.

Mr. Montzheimer: I think there ought to be a note at the

bottom that the turnout consists of everything except the rail in the turnout.

The President: That is acceptable to the committee.

The form was adopted as amended.

BALLASTING.

Sub-committees were appointed to gather data and prepare a report on customary recommended practice for preparation and delivery of various kinds of ballast; also advantages and disadvantages of various types of ballast. These sub-committees were as follows: (A) Crushed Rock; (B) Slag; (C) Gravel (Bank and Washed); (D) Chats; (E) Cementing Gravel and Chert; (F) Disintegrated Granite.

The committee submits new definitions for gravel and sand, to take the place of those heretofore recommended and published in the Manual.

The definitions adopted state that gravel is coarser than sand and that sand is finer than gravel, but fail to establish any limit of size, below which worn fragments of rock cease to be gravel and become sand. Therefore your committee recommends the substitution of the following definitions:

Gravel.—Small worn fragments of rock occurring in natural deposits that will pass through a 2½-in. ring and be retained upon a No. 10 screen.

Sand.—Any hard granular comminuted rock material, finer than gravel, which will be retained upon a No. 50 screen.

Preparation and Delivery of Ballast.

CRUSHED ROCK.

Under this head the committee gives a description of the Hog Mountain crushing plant of the Delaware, Lackawanna & Western, prepared by L. Bush, former Chief Engineer. It describes the equipment, method and cost of operation, and methods and cost of handling the ballast.

PIT GRAVEL.

Stripping.—In general, the best method for removing the waste material is to use a steam shovel. When the depth of stripping is too shallow to permit the economical use of a steam shovel, teams with scrapers can be used to windrow the strippings, using a steam shovel to load the windrows. The cost of stripping a gravel pit with a steam shovel, using the material to widen embankments, when the haul does not exceed 20 miles, should not be more than 15 cents per yard.

Loading.—A heavy steam shovel with a dipper holding from 2½ to 3½ yds. makes a most efficient machine for loading gravel. Too great stress cannot be laid upon the advisability of having a shovel which has a large surplus of strength in all its parts, as economy in maintenance and in the operation, resulting from lessening the loss of time occasioned by stopping for repairs, is very great. Center-dump cars, which deposit the material where it can be used without any casting with shovels, are most economical; the larger the capacity of the cars the better.

In connection with the center-dump cars, ballast spreaders mounted under a flat car are a necessity. The practice of placing a tie or like obstacle in front of the wheels, allowing them to skid while the ballast is being pushed out of the way, is bad, resulting in flat wheels, as well as loss of time in distribution of the ballast. Where only a small amount of ballast is to be handled, a device which will be mounted by the wheels and will itself slide on the rails can be used to good advantage. Where only a very small lift or none at all is to be made, a great saving in time of applying the ballast can be made by the use of a distributing plow, which plows out the ballast close to the tops of the ties.

Cost.—It is impractical to give any approximation of the cost of preparing the gravel pit for operation, as local conditions will govern entirely. The cost of loading the gravel depends upon three conditions: (1) The size and efficiency of the shovel. (2) The depth of the bank from which gravel is being loaded. (3) The supply of cars maintained under the shovel dipper.

Where the bank is 10 ft. or more in depth the greatest efficiency of the shovel should be obtained. Not less than four pitmen should be used, that no time may be lost in shifting. Where the bank is less than 10 ft. in depth it will generally be found that the frequent shifting of the shovel will materially reduce the output of gravel. It is assumed that the train service is sufficient to keep the shovel supplied with cars in order to make use of its full efficiency. With these conditions obtaining, from 2,000 to 2,500 cu. yds. per day on an average can be handled, the cost of which will be approximately $0.025 per yard.

Distribution.—The length of haul regulates entirely the question of the number of trains and the number of cars to a train which should be used. The one hard and fast rule should be that the best of motive power be furnished for this service. Generally speaking, for hauls less than 10 miles, one train in addition to the train at the pit is sufficient. Above 10 miles and under 30, two trains on the road will be sufficient. The only rule that can be stated is that, to get the most economical handling of ballast, train service enough should be provided to keep the shovel well supplied with empties at all times. Where the haul is short the best practice is to put into one train only so many cars as can be handled readily by the engines which are assigned to that service. There is a decided loss on short-haul work where more cars are put into a train than can be dumped without difficulty by the engine.

When the haul is long all the cars should be given to a train that can be moved over the division, and enough set off on the siding nearest the distributing point to reduce the train to such size that the engine can readily handle it while dumping. This applies to center-dump cars, where the movement of the train when being unloaded is very much harder than when on the road. In some cases it will be found economical to provide a train for the purpose of taking the loaded cars at the end of a long haul and unload them. It frequently happens that unforeseen delays occur during the unloading which will seriously cripple the through movement of the gravel trains, and on very long hauls the unloading train can be economically employed.

The cost of movement from the pit and of distributing on the track depends wholly upon the length of the haul and congestion of traffic. The actual time consumed in distribution with center-dump cars is immaterial, 30 minutes being sufficient time for the unloading of a train of from 400 to 500 cu. yds.

WASHED OR SCREENED GRAVEL.

The essential features of a plant for this purpose are:

(1) Positive separation of material into definite grades.

(2) Capacity to furnish gravel in quantities sufficient for economical use as ballast.

(3) Economical operation.

(4) Economical disposition of the refuse, both boulders and fine material.

To fulfill the first requirement a plant must be so designed as to separate the material handled into dust, sand, gravel and cobbles or boulders. If these grades are not separated the proper proportion of sand and gravel necessary for the best results cannot be obtained.

In distributing ballast on track it is obviously necessary to produce the gravel in large enough quantities to permit the organization of the track forces on an economical basis. A plant which will produce gravel at a cost which would make it commercially profitable may be too small to produce ballast economically.

In the preparation of quantities of ballast there is necessarily produced a large amount of mud, sand and boulders or cobbles. To work successfully, a plant must be so devised as to dispose of this rejected material. The stones should be run through a crusher and returned to the gravel for ballast, not only increasing the output, but improving the quality.

Plants for the washing or screening of gravel naturally divide into two types: (1) Those for handling material from submerged beds of gravel. (2) Those for handling material from upland gravel banks.

The plant of the Union Sand & Material Co., South Memphis, Tenn., is a typical submerged gravel-bed washer, and the Lake Shore & Michigan Southern plant at Pleasant Lake, Ind., is typical of the upland washer.

[Descriptions of both of these plants are given. The Pleasant Lake plant was described in the *Railroad Gazette*, September 14, 1906.]

CEMENTING GRAVEL.

There are two principal points in the territory east of Memphis where cementing gravel is worked for the purpose of supplying ballast to railroads; one at Iuka, Miss., on the Southern Railway, known as the Tishomingo gravel pit, owned and operated by the Tishomingo Gravel Co., of Memphis, and one at Perryville, Tenn., on the Memphis & Paducah division of the Nashville, Chattanooga & St. Louis Railway, owned and operated by the Perryville Gravel and Ballast Co., of Memphis.

Tishomingo gravel is a water-worn gravel lying in a compact mass requiring blasting before it can be handled with a steam shovel. It is composed of 20 per cent. clay, 5 per cent. sand, and 75 per cent. gravel. The cost in track is 47 cents a yard. The advantages of its use are: Small cost; quick cementing qualities; holds track in line and surface well under

fairly heavy traffic; does not churn; very little dust, and has great resistance to erosion by water. Considered an excellent ballasting material. Has the disadvantage of growing prolific crops of weeds and grass, making it costly to keep clean.

Perryville gravel is an angular gravel lying in a compact mass requiring blasting before it can be handled. It is composed of 10 per cent. clay and 90 per cent. gravel, with chemical analysis of 97 per cent. silica, 2.5 per cent. alumina, and .5 per cent iron. There is found in this pit considerable large stone, which has to be crushed before suitable for use. The cost of this gravel per yard in track is 71½ cents.

BURNT CLAY BALLAST.

Under this head the committee describes in detail the making of burnt clay ballast, including selection of pit site, method of operation, conditions producing best product, loading, desirable size and capacity of pit, and other practical points. They also give the following table showing the cost of burnt clay ballast on several railways:

Railway.	Land.	Fuel.	Contract price.	Loading.	Train service-hauling.	Putting under.	Total per yard.
A. T. & S. F.	....	0.100	0.200	0.058	0.237	0.140	73.5
C. & E. I.	....	....	...	...	....	....	25-30
C. B. & Q.	0.45	0.135	0.17	0.06	....	....	41
C. M. & St. P.	....	....	...	...	....	....	38-40
C. R. I. & P.	....	....	17-30	...	....	....	37-40
Union Pacific.	....	....	...	0.201	0.091	0.234	52.6
Wabash	....	0.038	0.240	0.040	....	....	31.8

CHATS.

Chats are tailings from lead and zinc concentrators. The rock in which the lead and zinc occur is run through crushers and separators and thoroughly washed, after which it is discharged by means of elevators and troughs, forming huge piles. The desire of the lead and zinc operators to extract every ounce of ore from the rock has led to finer and finer crushing, so that chats coarse enough to make good ballast are becoming less easy to obtain each year.

A great deal of loading is done by hand under contract. The material is, however, most excellent for easy steam shovel handling, and much is loaded that way. Cost of loading is now about 16 cents per yard in the Joplin district, having been 14 cents for some years and at one time even cheaper.

Advantages and Disadvantages of Various Types of Ballast.

Under this head the committee first enumerates the functions of good ballast preliminary to discussing the extent to which the different materials perform these functions.

CRUSHED ROCK.

After naming the advantages claimed for crushed rock by its advocates, the committee says: Users of large quantities of gravel ballast, however, do not admit all of these claims, particularly that of better riding track. It is said that when track is to be raised only a very small amount, it is difficult to do this on stone ballast and to properly tamp the tie to an even and uniform bearing. For this reason it is claimed that gravel makes a more smooth riding track. Likewise, it is more difficult and costs more to renew ties in stone, owing to the handling of the material. We have also heard it stated by foremen that it is harder to make and maintain very small adjustments of line and surface in rock than in other materials, but its good qualities far outbalance its poorer ones, and its use shows a material economic saving.

The best size for crushed rock is an unsettled question. Tests made on the Baltimore & Potomac Railroad indicate that there is a slight economy in the use of 2½-in. stone over 1½-in., and a decided saving over ¾-in.

A statement of results of physical tests of ballast stone is given in Appendix A to the report. This appendix also contains descriptions of the various tests, geological descriptions of the rocks examined and a study of the costs and comparative economy of some of the stones, as they apply to conditions on the Baltimore & Ohio.

"Characteristics of Stone Ballast" on the Cleveland, Cincinnati, Chicago & St. Louis are shown in Appendix B, which also contains some interesting comparisons of cost of stone and gravel ballast.

GRAVEL BALLAST.

Following an enumeration of the advantages and disadvantages of gravel ballast the report says: These disadvantages however, exist in greatly varying degrees, and in carefully prepared gravel ballast disappear altogether. While it is true that some of the users of crushed rock maintain that it is superior to the best gravel, your committee feels that the evidence is not sufficient to warrant them in making an unqualified statement to that effect. Under extremely heavy traffic the indications are that crushed rock will stand better than the best gravel, but some of the best riding track in the country, with fast passenger service over it, and with reasonable maintenance expense, is put up on gravel.

Some physical tests of pit gravel on the Big Four have thrown light on the question of effect of sand and dust in gravel ballast, and the result of the tests is accordingly given here. These tests were made on small sieves by hand and must therefore be regarded as laboratory tests, rather than working tests under everyday conditions:

PERCENTAGE OF GRAVEL, SAND AND DUST BY VOLUME.

(Compared to Original Volume.)

Pit.	Gravel.	Sand.	Dust.	Remarks.
Lafayette, Ind.	81.6	27.0	1.3	Very good.
Mechanicsburg, Ohio.	61.3	50.9	2.8	Fair.
Mound City, Ill.	68.0	44.1	2.9	Good.
Savona, Ohio.	86.0	12.5	6.5	Poor—Cementing nature.
Terre Haute, Ind.	56.0	62.0	2.0	Too recent to determine.
Valley Junction, Ohio.	59.6	55.4	3.6	Good but dusty and excess of sand increases track labor.
West York, Ill.	58.7	49.1	12.9	Very poor. Only fit for sub-ballast.

In what follows the term "dust" is applied to that material which is finer than sand under the new definition recommended by the committee. All proportions have reference to the bulk.

Gravel having 3 per cent. or less of dust has been found to drain very freely, while gravel having an excess of 3 per cent. of dust is found to hold water to such an extent as to interfere with its thorough efficiency as ballast.

Gravel containing 2 per cent. of dust will make a fairly dustless roadbed, but after being disturbed by track work it will cause considerable dirt until washed by a heavy rain.

It has been found necessary to have about 30 per cent. sand to partially fill the voids in the gravel. Lack of at least 20 per cent. of sand permits the pebbles to shift under the load and an excess of 50 per cent. of sand prevents the ballast from becoming firm. In dry weather "pumping" or "blowing" takes place.

Your committee recommends, as a good practice, the following proportions:

For Class A Roads: Ten parts gravel and three parts sand. Where bank gravel contains more than 2 per cent. dust or 40 per cent. sand it should be screened or washed.

For Class B Roads: Ten parts gravel and six parts sand. Where bank gravel contains more than 3 per cent. dust or 60 per cent. sand it should be screened or washed.

For Class C Roads: Ten parts gravel and ten parts sand. Any bank gravel which does not contain an excess of 6 per cent. dust may be economically used.

CHATS.

The principal advantage of chats is low first cost, although it has some very excellent qualities as ballast in addition to this. It provides as good drainage as the best gravel, the coarser chats giving better drainage than the finer. It is very low in cementing qualities and there are therefore fewer pumping ties than in gravel. It is fine enough for ties to be tamped with a shovel or end tamper, permitting a fine surface with a light raise. Weeds do not grow in the chats and they will not grow in the ballast until sufficient dirt to support them has been collected.

The specific gravity of chats varies from 2.54 to 2.66, and the weight of a yard varies from 2,100 to 2,400 lbs., averaging about 2,300 lbs. Recently the ore has been ground finer in order to get out more of the lead and zinc, which makes a less desirable ballast than when it is coarser.

Some of the disadvantages of chats are that they sink into clay soil, blow out under heavy joints and do not keep tracks in good line and surface under heavy traffic. The better grades of chats, those made of the harder rocks and more coarsely crushed, have always been somewhat dusty under high speeds, say about 45 miles per hour. This objectionable feature has grown worse with the tendency to finer grinding, mentioned above, until it has reached the point where some chats piles are entirely unfit for ballast purposes. Some of the ore-bearing rock, also, is comparatively soft by nature, and, with clay which sometimes occurs in the interstices of the rock, makes a material which does not drain nor support track satisfactorily and which, therefore, should not be used except for sub-ballast.

Conclusion.

Your committee asks that the definitions for sand and gravel be approved by the convention and that the percentages of sand and dust in gravel ballast given above be approved as good practice.

The report is signed by John V. Hanna (K. C. T. Ry.), Chairman; C. A. Paquette (C., C., C. & St. L.), Vice-Chairman; Willard Beahan (L. S. & M. S.); W. J. Bergen (N. Y., C. & St. L.); J. B. Dickson (Erie); H. O. Garman (Purdue Univ.); H. E. Hale (Mo. P.); G. D. Hicks (N., C. & St. L.); B. C. Milner; A. F. Rust (K. C. S.); W. C. Smith (N. P.); F. J. Stimson (G. R. & I.); A. W. Thompson (B. & O.); G. M. Walker, Jr. (A., T. & S. F.).

Discussion.

Mr. Hanna: The vice-chairman of our committee made some actual separations with screens of different sizes and the result was to offer a definite line that should be drawn between those two classes of material. As he is not here, we cannot give the explanation of the work done in arriving at these screen sizes.

C. E. Lindsay (N. Y. C.): I would request that we have the definition for gravel, as given in the Manual, read to us.

The secretary read it.

L. C. Fritch (I. C.): It seems to me the percentage of sand in the gravel for Class A roads is a little high. It strikes me that 30 per cent would be better.

Mr. Lindsay: I hope the definitions of the committee will not be adopted, changing the Manual. It seems to me that gravel is as it occurs naturally. Just last month I was attending upon a lawsuit where the question of the character of the ballast was in dispute and around which the question centered, and it was a question whether it was a gravelly sand or a sandy gravel. We claimed that it was the best that could be obtained in that locality in its natural condition. If this association goes on record as saying that a gravel ballast is a mixture of a certain definite quantity of sand and gravel, it seems to me we are going along the wrong lines.

Mr. Hanna: The idea of the committee was to draw a definite line between sand, gravel and dust. It is true that gravel is a natural deposit; so is sand a natural deposit. Ordinarily there is not any confusion in anybody's mind as to what these things are; but when it came to a discussion of them for ballast purposes it seemed to the committee that there was an advantage in having some definite test that the material could be put to, which would determine which class it would go into. That would have been clearer, I think, if we had here the samples of the material itself, that would show just exactly what is got by making the separation by the use of these screens that we have named in these definitions. I think in the absence of the actual material before you to see what it means to draw this line, that it is very difficult to convey to anyone else the right impression about it. The report gives the proportion of parts of gravel and sand. I am not able myself to say just what led to these particular proportions. They were determined by Mr. Paquette, who is chairman of the sub-committee, and they are the results of his work in using these different sizes of screens. The idea was that the proportion of sand should be as large as possible, keeping in mind the desirability of filling the voids between the stones of the gravel, and that the sand should not be in a large enough proportion to permit dust, or permit the sand to be drawn out by the air going along with a moving train. At high speed the trains would naturally pick up particles of a larger size than slower trains, and the idea was that for first-class roads there would not be enough sand to be at the surface of the gravel. Naturally the finer stuff works down through.

Maurice Coburn (Van.): I think that the percentage of sand suggested is too high. The larger the amount of sand the more dust we are going to have and the less the life of the gravel is going to be and the poorer the drainage. The reason for washing gravel is to minimize all those results. With our present gravel, the dust is a very serious matter in the summer time. I am very glad to read what the committee has had to say about the comparison between gravel and stone, because it agrees with my own conclusions. Gravel ballast will give us first class track for considerably less than we can have with stone, and we have stone and gravel both on our line.

Mr. Fritch: Our road has had considerable experience in river gravel, where we could get any desired quantity of sand, and our practice has been to limit the quantity of sand to from 30 to 35 per cent, which gave very good results. I think, for high speed track, anything in excess of that would make a dusty track.

Willard Beahan (L. S. & M. S.): There is more sand in gravel than you would think. If you would screen it you would be surprised at the result. I did not suppose I would ever advocate 40 per cent sand, but in the way we arrived at it we mixed it up, and considered how that compared with the results from our washers and our pits, and that percentage represents simply the practical judgment of the gravel men on your committee. It is not the sand that has so much damaged our gravel. It is a little film of clay that surrounds each particle of gravel.

Mr. Lindsay: In regard to the committee's recommendation to substitute the definition in the report for the one in the Manual: let us determine what will be called gravel, then we can determine what kind of gravel to use for the different classes of track. I move that the definition for gravel be rejected and that the definition in the Manual be retained.

There was no second to this motion.

Mr. Lindsay: With regard to the definition for sand, I move to omit the words "finer than gravel" and substitute the words "passing through a No. 10 screen."

W. M. Camp: I am in favor of drawing a line between gravel and sand, and when we define it as passing a No. 10 screen and being retained on a No. 50 screen, it seems to me that does draw a line. When you speak about ballast containing so many parts gravel and so many parts sand the association is compelled to define what sand is and what gravel is.

H. McDonald: There is another committee which will probably consider the definition of sand, and it is possible they may have already recorded themselves in the Manual, and that is the committee on Masonry. Are we to understand that this definition of sand applies to ballast only, or if we adopt it today will it be applicable to sand for use in concrete and masonry also? For my own part I would be perfectly willing to see it stand for both uses, as amended by Mr. Lindsay.

Mr. Hanna: Our committee looked at this from the ballast point of view only.

Mr. McDonald: Then they should define sand for ballast?

The President: The question is on the definition of sand. Mr. Lindsay's amendment is to eliminate the words "finer than gravel" and to add "will pass through a No. 10 screen," so that the amended definition would read: "Any hard grabular comminuted rock which will pass through a No. 10 screen and be retained upon a No. 50 screen."

The amendment was adopted.

Mr. Camp: I move that the definition of gravel be adopted as it stands.

Mr. Hanna: I move that the recommendations on proportions of gravel ballast be adopted.

Mr. Osgood (C. of N. J.): I would like to ask why, in stating proportions of gravel and sand, it is thought best to make them specific and not to state that the amount of sand shall not exceed a certain percentage? It would naturally occur to me that in specifying gravel it would be desirable to have it as near gravel as possible, and limit the amount of sand, and certainly it would be so in regard to some gravels, even under the specification of the committee. It might be wiser to say the proportion of sand shall not exceed a certain amount; then say it shall be such an amount, as is specified here.

Mr. Fritch: I would like to amend the motion by changing class A to read, instead of 40 per cent, a maximum of 35 per cent; for class B a maximum of 50 per cent, instead of 60 per cent.

Mr. Coburn: I agree with this recommendation. On our road we pick up with our fast trains a very large part of the material which is classed as sand by the committee.

Mr. Hanna: I believe that Mr. Fritch is under a misapprehension with regard to the committee's proportions. Ten parts of gravel and three parts of sand would make 13 parts in all, and the three parts sand is little less than 25 per cent. I confess I think it would be better to put it in the shape of percentages.

Mr. Byers: In regard to washed river gravel there should be a minimum. The river gravel, with insufficient sand in it, acts a good bit like shelled corn, and it is impossible to keep the track in proper shape. We have had some experience with that, with some gravel, that I think contained about 15, or possibly 20 per cent sand, but we have had a good deal of trouble to maintain the track with that material. Since that we have increased the percentage of sand and find the result very much better.

The President: The question is on the amendment to change the percentage on the class A roads from 40 to 35 per cent and on class B roads from 60 to 50 per cent maximum.

Mr. Hanna: I would not like to see it go through in exactly that form. I think in view of what Mr. Byers has said about his experience—and others have had the same—that we ought to have a maximum and minimum limit, and before the convention finally settles on this, we ought to have the

experience of other roads and know what their minimum limit has been, what has proved to be a good minimum limit. Then I think we would better rewrite this, so that the whole recommendation will be expressed in percentages and not in parts. The committee will do that.

H. R. Safford (I. C.): My experience in Mississippi river gravel has taught me that a maximum of 35 and a minimum of 28 per cent are proper limits. We started out with a specification 25 per cent, and found that was not sufficient, and gradually increased it to 30, to 35, and with that character of gravel we find no trouble with the sand being picked up by moving trains. Our recommendation would be, minimum 28, maximum 35.

The amendment offered by Mr. Fritch was voted upon and was defeated.

Mr. Hanna: I would like to get a more definite expression of the convention on the maximum and minimum question. I would like to have some sort of a vote that will fix those two limits.

Mr. Fritch: I move that the recommendations of the committee for ballast for the different classes of roads be referred back to the committee for further recommendations.

Motion carried.

WATER SERVICE.

The work assigned to the committee by the Board covers:

(1) The relative economy of different fuels used in pumping water, with the relative desirability of each.

(2) General principles of water supply service (water treatment not considered) and typical installations for various conditions.

(3) Report on various types of track tanks with designs of typical installations and critical review.

Relative Economy of Different Fuels.

The different fuels used by railroads in pumping water are: coal, gasolene, kerosene, distillate, fuel oil, artificial gas (from municipal plants or gas producers), natural gas. Compressed air and electric power are also used where obtainable from other plants or where duty is great enough and conditions favorable to their use.

Circulars were sent to members of the association requesting reports on the relative merits of the different fuels. Twenty-four replies were received; of these, ten were considered of sufficient reliability to warrant tabulation. From these reports, which are given in Appendix A, deductions were arrived at as follows:

(1) That gasolene and coal are the only fuels that are in common enough use at the present time to enable a report on their relative economy for railroad pumping plants to be made by the committee.

(2) That the reported actual consumption of fuel by the average railroad pumping plant is larger by several times than it should be according to the tests of machinery on the testing floor. This is due to the small size of plant, causing the percentage of efficiency to decrease; careless and inefficient employees; careless and inefficient manner in which accounts are kept.

(3) That the actual fuel consumption per effective horse-power per hour is as follows:

	Amounts per effective horse-power per hour. Up to 50 E. H. P.	
Number and description of tests.	*Coal used, pounds. 10 tests effective h. p. from 1.37 to 4.61	Gasolene used, gallons. 24 tests effective h. p. from 0.51 to 4.67.
Maximum	67.	0.98
Minimum	30.	0.24
Averages of all tests	50.	0.50

*Coal ran from 14,000 to 10,000 B. t. u. per lb.

On larger plants, for which only a few tests have been received, the amounts per e. h. p. are considerably less, although the ratio remains about the same.

An article on the relative value of coal and gasolene as a fuel for railroad water stations, by A. K. Shurtleff (C., R. I. & P.), is published as Appendix H of the report. This article has been used as a basis by the commitee in the calculations for size of pumping plants.

The conclusion is reached that 100 lbs. of coal will do the same work as 1 gallon of gasolene; or coal at $3 per ton unloaded in the pumphouse bin is equivalent to gasolene at 15 cents per gallon delivered in the gasolene storage tank.

The relative cost of repairs and depreciation of steam and gasolene plants is a question on which the committee has not been able to get very definite figures. The figures in Appendix B indicate that there is not a great deal of difference. Appendix B-1 shows the actual cost of repairs to gasolene plants per 1,000 gals. pumped.

It is difficult to arrive at a definite conclusion as to the question of labor. Local conditions govern largely and the committee believes that with plants of the same capacity the labor charge would be the same with coal as with gasolene. This conclusion is arrived at for the reason that the committee does not wish to recommend that a gasolene engine be left to run itself without intelligent supervision, and it should have nearly as much as a steam plant has to have.

In conclusion, the committee would recommend that the selection of steam as a motive power be made in accordance with the following conditions:

(A) Where 100 lbs. of coal unloaded into a pumphouse is cheaper than 1 gal. of gasolene delivered in gasolene storage tank, taking into consideration the number of hours the plant is to be operated and the location of plant as regards delivery of fuel; special attention also being paid to the proper design of pump as regards size of steam and water cylinders on large plants.

(B) Where a steam plant is maintained for other purposes, as at terminals where shops are run by steam.

(C) Where interest charge on plant is less than it would be on a gasolene plant.

The selection of gasolene as a motive power should be made in accordance with the following conditions:

(A) Where 1 gal. of gasolene delivered in gasolene storage tank is cheaper than 100 lbs. of coal unloaded into the pumphouse, special consideration being given to locations remote from trackage and isolated stations where train service is such that pumper can, by pumping the whole of his time between trains, do the pumping at two or three stations.

(B) Where the quality of the water is such that it will necessitate heavy boiler repairs, provided boiler compounds cannot be successfully used.

(C) Where interest charge on plant is less than it would be on a steam plant.

General Principles of Water Supply Service and Typical Installations for Various Conditions (Water Treatment Not Considered).

The general principles of water supply service are considered under the following subdivisions: (1) Quantity of water required. (2) Sources of supply. (3) Method of gathering supply. (4) Pumping plants. (5) Method of delivery to locomotives. (6) Typical installations. (7) Methods of operation.

QUANTITY OF WATER REQUIRED.

This should be carefully considered in accordance with the following subdivisions: (A) Amount at terminals. (B) Amount per train mile. (C) Capacity of tanks.

The committee recommends that further investigation be made as to the quantities of water required under the above headings for the various classes of traffic recognized by the association.

SOURCES OF SUPPLY.

All waters should be chemically analyzed and this analysis considered in connection with the decision on source.

The committee recommends that a supply be obtained, if possible within economical limits, sufficiently large so that the total amount of water likely to be required during the average volume of business in 24 hours can be drawn from the source in four hours at intermediate stations and in seven hours at terminal stations.

[The committee then enumerates the various sources of supply, commenting on the suitability of each. These include city water; springs; lakes, natural ponds, creeks or rivers; surface-pumped wells; artesian wells; deep wells pumped. Where city water can be bought at an economical figure, and in sufficient amount and of suitable quality, the committee recommends this source of supply above all others.]

METHOD OF GATHERING SUPPLY.

Springs.—The style of construction of reservoir or intake is largely a matter for local consideration. Springs should be covered so as to keep out organic matter. If the spring is at a suitable elevation, so that a gravity supply can be arranged, and there is no danger of shutting off the supply, and the character of the ground will permit, it is well to excavate and wall the spring to serve as a collecting reservoir.

Lakes, Natural Ponds, Creeks or Rivers.—These sources require special investigation for each case. In making this investigation special consideration should be given to future pollution, sediment and riparian rights. The existence of organic matter in excess will cause foaming and is to be avoided, as it cannot be removed by any practical process. The existence of

sediment involves the construction of a filter or a settling basin. The question of filters is a problem in itself and the committee recommends that it be taken up as a separate subject in later reports. The size of settling basins is the principal thing to be determined and the following data are required:

(1) How long does the water have to stand at different depths at the time of year when it contains the most sediment in order to clarify. (2) Maximum quantity of water to be used in 24 hours. (3) Topography and character of soil at proposed location to determine whether basin can be on top of ground or submerged.

Dug Wells.—No dug well should be started until careful tests have been made at the proposed site with an auger to determine probable depth and character of water-bearing strata. The size of the well required will depend upon the porosity and thickness of the water-bearing strata, no definite rule for which can be given. For locomotive service the minimum inside diameter should be 8 ft., with 18-in. walls, and the maximum diameter should be 30 ft., with 30-in. walls.

Surface Pipe Wells.—A drawing in Appendix F shows the style of pipe wells recommended and gives the details of construction. These can be located close to the pump, or each other, or at some distance and scattered over a large area where necessary, in order to get a sufficient supply of water.

Deep Wells.—The construction of artesian deep wells and pumped deep wells is the same, with the addition to the latter of working or pump barrel, drop pipe and pump rods, and is shown in Appendix G. It is recommended that where the depth is expected to reach 50 ft. or more and no reliable data are on hand in regard to the strata to be passed through, that a start be made with 12-in. pipe. In the completion of a pumped deep well it is recommended that the drop pipe be first lowered so that the cylinder is just submerged and then tested for capacity of well. If this proves insufficient, lower another length and retest, and continue this until the desired supply is obtained. In this way the size of the pumping plant can be more readily determined.

PUMPING PLANTS.

The size of plant is the first question to be considered. The committee recommends that if sufficient water is obtainable the plant should be of such size that the amounts of water as shown by the accompanying table can be pumped:

Quantity per 24 Hrs. in Gallons.	Terminal Stations.		Intermediate Stations.	
	Time Pump to Run in 24 Hrs.	Gallons per Minute.	Time Pump to Run in 24 Hrs.	Gallons per Minute.
2,000,000	20 Hours	1,666	20 Hours	1,666
1,750,000	20 Hours	1,458	20 Hours	1,458
1,500,000	20 Hours	1,250	20 Hours	1,250
1,250,000	20 Hours	1,042	20 Hours	1,042
1,000,000	20 Hours	833	20 Hours	833
900,000	20 Hours	733	20 Hours	733
800,000	20 Hours	666	20 Hours	666
700,000	20 Hours	583	20 Hours	583
600,000	20 Hours	500		
			10 Hours	1,000
500,000	7 Hours	1,189	10 Hours	833
450,000	7 Hours	1,071	10 Hours	750
4000,00	7 Hours	928	10 Hours	666
350,000	7 Hours	838	10 Hours	583
300,000	7 Hours	714	10 Hours	500
250,000	7 Hours	595		
200,000	7 Hours	476	4 Hours	1,041
150,000	7 Hours	357	4 Hours	833
100,000	7 Hours	238	4 Hours	625
50,000	7 Hours	119	4 Hours	416
25,000	7 Hours	60	4 Hours	208
			4 Hours	104

Table of Amounts of Water to be Pumped.

At plants where it is necessary to run 20 hours, duplicate machinery should be provided.

The quantity of water to be delivered having been decided upon, the next question is the size of the discharge pipe. The following formula is submitted for this determination. The constants given will vary slightly with local prices, but the percentage will be so small that this feature can be neglected:

C = Cost of main per lin. ft. laid, assumed as follows, with pipe at $25 per net ton: 4 in. at 65c, 6 in. at 80c, 8 in. at 95c, 10 in. at $1.20, 12 in. at $1.50, 14 in. at $2.15.

I = Interest on one dollar for one day at 6 per cent per annum = $0.000164.

P = Cost of fuel only to raise 1,000 gals. of water 1 ft., assumed at $0.0003 per 1,000 gals., on a basis of coal at $2 per ton, or gasolene at 15c per gal. (from actual tests).

Qd = Average quantity of water to be pumped per 24 hours in 1,000 gals.

Qm = Gallons per minute plant is to handle.

H = Friction head in feet for 1 ft. of pipe for quantity of water plant is to handle per minute.

D = Inside diameter, cast-iron main.

D is economically proportioned where the interest cost of pipe investment per day = daily cost of fuel overcoming the friction head, or:

$$I \times C = P \times Qd \times H.$$

Substituting for C, I and P the values assumed above and solving for Qd and H for different sized pipes, the following is obtained:

Use 4 in. cast-iron pipe where Qd × H = 0.355
Use 6 in. cast-iron pipe where Qd × H = 0.437
Use 8 in. cast-iron pipe where Qd × H = 0.519
Use 10 in. cast-iron pipe where Qd × H = 0.656
Use 12 in. cast-iron pipe where Qd × H = 0.820
Use 14 in. cast-iron pipe where Qd × H = 1.162

The number of gallons per minute, size of discharge pipe, and static head being known, we can determine the *effective horsepower*. The various tables for friction in water pipes can be used in substituting in the above formula and in determining the friction head. It is well to add about 50 per cent. to the friction head, as per tables, in calculating the friction head for the proposed plant to provide for incrustation of pipe lines, especially if the water to be pumped has been treated.

The following formula is a short method of obtaining the effective horsepower (E. H.P.):

$$\text{E. H.P.} = \frac{\text{Gals. per Min.} \times \text{Static Head and Friction Head in Ft.}}{4{,}000}$$

BOILERS.

Where steam is used as power the question of the most economical boiler must be considered. This is a question which the committee has not been able to analyze as thoroughly as it should be, and it is recommended that this question be gone into more thoroughly by future committees, especially for small plants, 5 to 25 h.p. The types which seem to find the most favor are the locomotive type, manufactured in sizes 15 to 25 h.p., and the vertical submerged flue type, manufactured in sizes 5 to 50 h.p.

The following items should be taken into consideration in the selection of a boiler: Kind of water, kind of fuel, location of plant as regards availability of labor for repairs, and size of plant. Boilers should carry 100 lbs. pressure for railroad pumping plants.

[Taking this boiler pressure the committee works out in detail the method for finding the number of square feet of heating surface required for the boiler. The usual commercial rating is 10 sq. ft. of heating surface per boiler horsepower.]

Appendix I gives in tabular form the boiler horsepower required for assumed conditions per effective horsepower from 1 to 15 for vertical and locomotive type boilers.

Gasolene Engines.—Where gasolene is used as power, on account of the high speed of gasolene engines, it is always necessary to reduce this speed by means of geared or belted connections for the operation of the pump. The committee recommends that gearing having cut teeth be used in preference to belting and that a friction clutch be introduced in order to be able to start the engine with no load; all of this machinery to be mounted on one substantial base and foundation with the engine, so as to prevent same getting out of line. The power should then be transmitted to the pump by a shaft making the same speed as the pump. In this way the pump can be set some distance from the engine, this generally being desirable on account of location of pumps in pits. This layout avoids the troubles incident to a high-speed shaft getting out of line.

Gasolene engines are usually sold on a brake horsepower basis. In order to obtain the proper size add 100 per cent. to the e. h.p. for friction in pump and for a safety factor. This is based on 66⅔ per cent. efficiency in the pump and gearing, and using 75 per cent. of the power of the engine.

SURFACE PUMPING PLANTS.

These are plants where the suction lift is such that the pump cylinder can be placed at the surface of ground or in a pit of moderate depth.

Surface Steam Pumps.—[The duplex, single-expansion, double-acting pump was the only one considered. Explanation was given for finding the cylinder sizes.]

Power Pumps.—In the case of gasolene, where pump and engine can be placed on the same level, the triple single-acting, duplex double-acting, and for small plants the combined engines and pumps, are very desirable devices. Where the pump must be at a lower level than the engine the double-acting, single-cylinder, connected to shaft by means of face plate and pitman, should be used. This face plate should be provided with several different wrist pin poles so as to vary the length of stroke. The following lengths of pitman and strokes per minute are recommended, based on the stroke length as four times the length of the stroke with a minimum length of 6 ft. and a piston speed of 70 ft. per minute:

For stroke	12 in.,	pitman length		6 ft.,	strokes per minute,				70
"	"	18 in.	"	"	6 ft.,	"	"	"	46
"	"	24 in.	"	"	8 ft.,	"	"	"	35
"	"	30 in.	"	"	10 ft.,	"	"	"	28
"	"	36 in.	"	"	12 ft.,	"	"	"	23

DEEP WELL PUMPING PLANTS.

These are plants where the suction lift is such that the pump cylinder or working barrel has to be placed inside of pipe well at a considerable distance below the surface of the ground, rendering the construction of a pump pit impracticable.

Appendix G shows the layout below the floor of pumphouse, and this is analyzed under the head of "Deep Wells." The steam pumping plant seems to give the best satisfaction for this class of well.

The steam head, or artesian well pumping engine, is made in various sizes. The stroke varies from 18 in. to 36 in. The 36 in. stroke is the one generally used where water supply is sufficient. These engines should be provided with displacement plungers in order to keep flow of water uniform and prevent shock. They should also be so designed that the engine can easily be removed and disconnected from the pump rod to facilitate barrel repairs.

PUMPHOUSES.

Pumphouses should be built of concrete, stone or brick. Pump pits should be made waterproof, if possible. For steam plants a coal bin should be provided that will hold at least a car and one-half of coal. Gasolene storage tanks should be located in a fireproof pit at least 25 ft. from the engine. In no case should gasolene engines be placed below surface of ground.

In the case of deep wells the pumphouse should be so designed that the portion over the well can be removed or opened sufficiently to allow a well machine to be set over it for use when repairs are necessary.

PIPING.

Discharge from pump should always be provided with an air chamber and check valves if same are not on the pump itself. Connections should be made below frost line with check and waste valve for boiler feed or gasolene engine jacket. In surface pumped plants a by-pass, or priming pipe, from discharge to suction should be provided. In open wells the bottom of suction pipe should have a combination strainer and foot valve. Where pump pits are not waterproof or water is likely to come up over pump at times, a branch suction pipe with a valve having a long valve stem extending above high water should be provided in order to pump down the water in pit.

Water Stations.

SUBSTRUCTURE.

Most plans for timber substructures of 50,000-gal. tubs call for 12 posts which require 12 foundations, while on the other hand a number of steel substructures have been built with but four posts and foundations. The life of a steel substructure is easily four times that of timber at about the cost for maintenance. The scrap value of a timber substructure is very small, while that of steel is large.

The height of substructures in early days, and still to a large extent, has been such as to place the tub just a sufficient distance above the rail to accommodate locomotives taking water. The use of water columns and larger locomotive tenders resulted in many substructures being made about twice the former height to reduce the time of taking water; and while that was accomplished, it might have been done in another way without increasing the head on the pump, for the required discharge "q" is the product of the area "a" of the pipe, and the velocity of whater "V" ($q = a V$), or the discharge varies directly with both "a" and "V." The velocity for head "h" is $V = \sqrt{2gh}$, in which "g" is the acceleration of gravity. The velocity therefore varies only as the square root of the head. For 16-ft. head $V = 4\sqrt{2g}$; for 32-ft. head $V = 5.6\sqrt{2g}$. Hence doubling the head only increases the theoretic velocity 40 per cent., which in fact is not obtained, since the friction in column supply line, which must be necessarily considered, increases nearly with the square of the velocity. The other factor "a" varies as the square of the radius ($a = \pi R^2$), while the perimeter varies only directly as twice the radius ($p = 2\pi R$), or doubling the radius quadruples the area, but only doubles the perimeter or weight of pipe required. When friction is considered the theoretic discharge is further increased, since the friction decreases as the diameter increases. Therefore, increasing the height of substructure increases the discharge by less than the ratio between the square roots of the two heads; increasing the radius of the pipe increases the discharge by more than the ratio between the squares of the two radii.

This theorem, with the friction factors involved, when applied to any situation will enable estimates to be made comparing the construction costs of securing the required discharge, but ultimate economy requires consideration of operating costs, which influence heavily on account of their cumulative effect. The operating factor to be considered is the increased head against which the pump acts when the tub is raised, the work performed being directly proportional to the head, and the fuel consumption likewise.

With regard to actual delivering capacities of water columns under ordinary heads, your committee have report of careful test of 12-in. column supplied by 14-in. main, which delivered 5,000 gals. per minute under 20-ft. head above column, and have measured the capacity of same size water column and supply line under 40-ft. head. The time of opening and closing automatic column valve was not included and the tests lasted 45 secs. The water was delivered at a rate of 6,200 gals. per minute. The conditions surrounding these two tests were not identical, but the latter had double the head and should therefore have had a theoretic discharge of 7,000 gals.; failure to do so is because of increased loss in friction due to increased velocity before mentioned and perhaps to a difference in the friction factors of the columns. With these discharging capacities we have data for comparing the time required to take water. Assuming 7,000 gals. as the capacity of tender tank and 6,500 gals. as the average quantity taken, the time required would be 1 min. 18 secs. under 20-ft. head, and 1 min. 3 secs. under 40-ft. head, or the increased height, 20 ft., of tub saves 15 secs. The time of swinging column and opening and closing valve is not included. Where the demand for prompt movement requires consideration of items as small as 15 sec. while taking water, the traffic is beyond water columns and calls for track pans.

The economical arrangement of tank and column ordinarily, is a height of substructure which places the tub 15 to 20 ft. above the rail, using a column of such size as will furnish the desired discharge.

DESIGN OF SUBSTRUCTURE.

The number of posts should be as small as consistent and composed of one or two simple, stout shapes rather than of small thin angles latticed together. This will result in fewer foundations, cheaper painting, less surface exposed to corrosion, if neglected, hence less danger in that event with simple, stout shapes than with complex posts of thin angles. This also holds true with the design of the remainder of the substructure.

TUB.

Kind of Material.—[The committee discusses the several woods used for tubs, including white pine, cypress, redwood and fir. A tub manufacturer says:] "The length of life of a tub depends almost entirely on local conditions. The lumber and hoops are affected by the water, the tub rots more rapidly if not kept filled and the outside decays and the hoops corrode if not kept painted. We have known pine tubs to last six years and we have known them to last 30. It would seem to us that a first-class pine tub, well hooped, should last 20 years if kept painted on the outside and reasonably full of water." A Southern manufacturer places the life of cypress tubs at 25 years, if properly cared for. Cypress tubs cost about 25 per cent. more than pine.

The use of a water table, band or finish at the bottom of the tub is disapproved, as it fosters decay. The usual thickness of staves and bottom is 3-in. material surfaced to about 2¾ in. This size does not appear too thick, and on the other hand it is doubtful if thicker sizes would be justified, as decay, when thoroughly started, would allow of but little longer life due to thicker material.

Specifications for white pine tubs are given in the conclusions.

HOOPS.

It has been the practice to make hoops thin, increasing the section as necessary by making them wider, with slight increase in thickness. The thicker hoops, still being thin and spread out, offer greater surface for corrosion behind the hoops. Thin hoops are used because they fit the staves better, but no matter how close the fit, it is not close enough to exclude the water entirely, and corrosion of wide thin hoops results in materially affecting the strength before the tub has served its life. This results in broken hoops, involving the expense and danger of replacement and, not infrequently, collapsed tubs. The hoops classed as thin are $\frac{5}{16}$-in. and ⅛-in. thick, the cross-section of which consist of mere threads of unattacked metal when removed. Most manufacturers place the maximum thickness at $\frac{5}{16}$ in. Your committee believes

the advantage of thicker hoops offsets the merit claimed for thin hoops, particularly as neither will fit into depression unless hammered, in which event there is not much difference in the contact. No manufacturer has used semi-elliptical hoops.

The wider the hoop, the better the condition for decay behind it; the narrower the hoop the more expensive on account of more lugs and handling. Four-inch hoops are narrow enough to allow of lugs having but one bolt, which is generally recommended, since with two bolts there is no certainty regarding the strain in either. Pressed steel lugs are considered best by the manufacturers. The selection of the uniform size, 4 in. x $\frac{5}{16}$ in., for all hoops, which is desirable for the sake of reducing the number of sizes, also commends itself for the above reasons. The spacing shown on the recommended plan is based on a wrought-iron hoop with working area of 4 in. x $\frac{5}{16}$ in., safety factor of 4 and allowable working stress of 12,500 lbs.

Steel Tanks.

A manufacturer of steel tanks gives as a conservative estimate of the life, five times that of wood, which he places at 10 or 15 years.

The types include the hemispherical bottom tank supported by a steel tower, the flat bottom tub, the hemi-ellipsoidal bottom tub, and the standpipe tub.

[Figures on costs are given. Some flat bottom tubs built in the Nevada desert, ranging from 65,000 to 350,000 gals. in capacity and with varying heights of substructure, cost from $3,252 to $6,722. The cost of hemi-ellipsoidal bottom tubs, which are patented, are given by the manufacturer as about $1,800 for a 50,000 gal. tank, and $3,000 for a 100,000 gal. tank, exclusive of foundation, roof and freight. Costs on the standpipe type as built by two western roads range from $2,000 to $5,000 for a 24 ft. tank, depending on height and character of foundation. A 50,000 gal. storage tub on timber substructure and concrete foundation costs somewhere about $1,800. The cost on steel substructure varies largely with the design of substructure, but $1,800 is an approximate figure.]

Delivery Lines from Tubs.

TANK SPOUT AND COLUMN SUPPLY LINE.

When the cost is not of first importance, or when the objections to tank spout are not nullified by local conditions in special cases, the use of water columns instead of tank spouts is recommended as good practice.

The committee did not make tests to determine the losses in the column supply line, but presented a discussion of same from data in its possession. A 12-in. water column and 14-in. supply line delivered 5,000 gals. per minute under a head of 20 ft. above the column nozzle; the pressure head in the 14-in. main just before entering column was 12.25 ft. above the same datum. A formula was worked out from which the total head was found to be expended as follows: .8 ft. lost at entrance; 5.3 ft. lost in friction between column and tank; 10.9 ft. lost in column valve and column; 3.0 ft. effective velocity head of issuing stream. This indicates that an increase in the discharge from a tank might be obtained through improved design in the column valve rather than by increasing the size of the supply line.

Methods of Operation.

The committee recommends that it is much more economical, from a maintenance standpoint, to hire regular pumpers to do the pumping at both steam and gasolene plants rather than depend upon some other employee.

The committee recommends that accurate record be kept of the cost of pumping water per effective horsepower and comparisons be made of the different plants. This record will frequently develop some weak spot in the plant on which a few dollars spent would mean a large saving in operation.

Appendix C gives "Pumping Report" recommended.

Appendix D gives "Monthly Record of Cost of Water Supply."

Appendix E gives "Water Station Record." In using this it is designed to have one page for each water station and have the sheets bound in loose leat so that additions as made can be added after a page is full.

Conclusions.

Your committee desires to submit the following conclusions in regard to the general principles of water supply:

Supply Quantity.—If possible within economical limits supply should be obtained sufficiently large so that the total amount of water likely to be required during the average volume of business in 24 hours can be drawn from the source in 7 hours at terminal stations and in 4 hours at intermediate stations.

Supply Source.—Where water of suitable quality, and in sufficient quantity, can be purchased at a reasonable figure, it is recommended above all other sources.

Springs should be carefully gaged for a period of at least one year and the possibility of future pollution and increased demands for supply therefrom carefully considered before their adoption as a permanent source. Reservoir should be constructed at spring where conditions will permit.

Lakes, natural ponds, creeks or rivers require special investigation in each case. Points to be considered are quantity, quality as regards chemical impurities and amount of sediment carried, future pollution and riparian rights. Style of intake will depend on local conditions entirely. No definite rules can be given.

Dug well construction should always be preceded by a careful auger test to determine strata to be encountered. Size and construction depend on strata to be passed through, and no definite rule can be given.

Surface pipe wells are very satisfactory where local conditions permit of their use. The system is one which can be extended to collect a large volume of ground waters.

Artesian deep wells, where obtainable, are very satisfactory source. Their flow is liable to constantly decrease and finally stop altogether.

Deep wells requiring pumping are only recommended as a last resort.

All waters should have chemical analysis made and the question of cost of treatment if required thoroughly investigated, as previously outlined in the Manual.

Pumping Plants.—Size of plant should be in accordance with table given under that heading.

Static head should be obtained. Friction head should be calculated in accordance with friction tables and 50 per cent. added thereto for the ageing of the piping system.

Steam should be selected for power for plants up to 5 e. h.p. (in accordance with formula given) when most of the conditions recommended in this connection in the report obtain.

Adoption of the recommendations for boiler size and for steam pump is asked.

Gasolene engine selected should have a commercial brake horsepower rating of twice the effective horsepower. Engine and gearing for reduction of speed should be all on one base, with friction clutch connection to pump shaft.

Adoption of the recommendations as to power pumps, deep well pumping plants and pump houses is asked.

WATER STATIONS.

Where the topography will permit full elevation the arrangement may consist of an elevated reservoir, excavated in the ground, with pipe line and water column.

Where only partial elevation can be secured it may consist of a tub resting on the surface, with pipe line and water column.

Where the topography will not offer even partial elevation, same must be secured by artificial means, permitting of choice in location of the supply, which is done by placing same (a) near the track, reducing the cost of delivery line, and (b) distant from the track, although at increased cost of delivery line.

The prevailing topography makes artificial elevation necessary at a large majority of water stations, resulting in the structure known as a storage tank.

STORAGE TANKS.

The foundation should be made of any good masonry locally available, provided it also withstands the disintegrating action of water.

It should be carried below frost line and as much deeper as necessary to reach firm bearing, unless piles or other subfoundations are used.

For substructure and joists the use of steel is recommended. Increasing the height of the substructure increases the discharge by less than the ratio between the square roots of the two heads. Increasing the size of the column supply line increases the discharge by more than the ratio between the squares of the two radii. The work of pumping, hence fuel consumption, is directly proportional to the head pumped against.

Twelve-inch columns are practicable and in most cases sufficient with tub 15 to 20 ft. above the rail, which is recommended as the most economical height.

In special cases it may be more economical to use substructures higher than 15 to 20 ft. on account of the length of column supply line or because the source of supply is elevated, particularly when from a municipal plant.

Tub.—The life of white pine tubs used in the past does not exceed 20 years, the quality used at present is inferior and will have a life of less than 20 years, the price has been increasing rapidly, even with the use of inferior lumber. The life of cypress used in the past does not exceed 25 years, the quality at present is as good as in the past, the price has been rapidly increasing. Further increase in the price of wood tubs is to be expected in view of the rapid depletion of forests. The use of wood in tubs limits the capacity of same.

SPECIFICATIONS FOR 50,000-GAL. WHITE PINE TUBS.

(1) (a) The inside diameters shall be 24 ft. at the botton and 23 ft. at the top. The staves shall be 16 ft. long. The tub shall be made of carefully selected white pine lumber, surfaced to 2¾ in., which is free from sap, shakes, unsound knots, or other imperfections which can cause leaks or will impair the durability of the tub. (All small black knots extending entirely through the plank shall be carefully bored and thoroughly plugged.)* All staves shall be full length without splicing. Every joint shall be machine-made and perfect, and the stave joints sawed on true radial lines, with due regard to top and bottom diameter of tub.

(b) The crozing of bottom of staves shall be cut with proper regard for pitch of stave when in position, and circular in shape, so as to be completely filled by tub bottom when staves are driven up.

(c) The outside of staves shall be surfaced convex so as to give a full bearing to hoop throughout the width of each stave.

(d) The tub shall be provided with hoops, as shown on plan, with single bolt pressed steel draw lugs and bolts for tightening.

(e) One extra stave and dowel pins shall be furnished with each tub. Every tub shall be set up at the factory and the bottom and corresponding stave marked and numbered before being knocked down for shipment. The location of the hoops shall also be marked on the staves.

(f) Hoops should be of muck bar iron, 4 in. wide by 5-16 in. thick, spaced as shown on plan, furnished in three sections and equipped with one-bolt pressed steel lugs and bolts.

(2) Roof may be of material and design to conform with available markets and other structures.

(3) Wooden Storage Tanks.—The plan submitted in Appendix K is recommended as good practice.

STEEL STORAGE TANKS.

Steel tanks are recommended as good practice unless the character of water prevents their use. They have a life more than double that of wood and larger scrap value when dismantled; the first cost is not much greater than wood, while the cost for proper maintenance of either is about the same. Provision for increased storage can be made with steel tanks when first erected, the additional capacity to be obtained by making tank higher whenever necessary at small cost compared with that of an additional wooden tank. Further merit of steel tanks is reflected in conclusion under "Tub—kind of material," stated earlier. The hemispherical bottom steel tank with steel substructure is not used ordinarily except at terminals. Three types of steel tanks are used at intermediate water stations, viz., flat-bottom tub on steel substructure, hemi-ellipsoidal bottom tub, supported by steel posts around the outside, and a cylinder or mud-drum 5 or 6 ft. in diameter at the center of the bottom, the mud-drum serving as frost-proofing for the tank and column supply lines, and as a settling basin for sediment which is washed out through blow-off valve.

Standpipe tub, consisting of a tub imposed directly on the foundation, the substructure being omitted. The portion below the water column nozzle acts as a settling basin for sediment, which can be readily washed out. This type may be used as a combined storage tank and water softener, the raw water and chemicals being introduced at the bottom, the treated water being drawn from upper portion by means of a floating intake.

TUB UNIT CAPACITY.

(1) The tub unit capacity at intermediate water stations depends on the relation of consumption, cost of installation and operation. It is recommended that the unit be at least 50 per cent greater than the maximum daily consumption when erected.

(2) The tub unit capacity at terminals also depends on the relation of consumption, cost of installation and operation. The unit capacity in this case is particularly subject to local conditions and no general relation obtains between it and the consumption. Ordinarily the tub serves as an equalizer to take care of heavy and light periods during the 24 hours, and the unit is generally less than the consumption.

*When cypress is used, omit sentence about small black knots.

WATER COLUMNS.

When the cost is not of first importance, or when the objections to tank spouts are not nullified by local conditions in special cases, the use of water columns is recommended as good practice.

Supply line should be same size as column where distance to storage tank is not over 100 ft.; where distance is greater, one size larger is recommended.

Column pit should be waterproof and drained.

Column valve should operate from locomotive tender only, and should be water-cushioned and provided with automatic drain for part of column above freezing line in cold climates.

Turning device should operate from tender or ground and have automatic lock to keep horizontal part of column parallel to track.

Horizontal pipe, when flexible joints are used, should have vertical movement sufficient to accommodate high and low engine tenders.

All moving parts of column for operating same should be easy of access.

OPERATION.

Regular employees should be kept in the service whose principal business is the operation of the pumping plant. A traveling repairman should visit each plant periodically and attend to all repairs, which cannot be made when plant is running.

Accurate records should be at hand in the office of the official having charge of this branch of the service, as indicated by Appendix E.

Accurate reports of pumping service should be kept, as indicated in Appendices C. and D.

The report is signed by C. L. Ransom (C. & N.W.), Chairman; M. H. Wickhorst (C. B. & Q.), Vice-Chairman; J. L. Campbell (E. P. & S. W.), J. P. Congdon (O. S. L.), Robert Ferriday (C. C. C. & St. L.), G. H. Herrold (C. G. W.), E. G. Lane (B. & O.), L. B. Merriam (G. T. P.), C. A. Morse (A .T. & S. F.), L. P. Rossiter (B. & O.).

Discussion.

Mr. Ransom: The committee presents for publication in the Manual the elementary principles, so that more elaborate work can be done a little later.

The secretary read the first conclusion.

C. E. Lindsay (N. Y. C.): I think the word "maximum" instead of "average" would be better.

Mr. Ransom: The word "average" was used because the committee thought we needed a little room to go there on account of the excessive volume of business at certain times of the year.

C. F. Loweth (C., M. & St. P.): Why should the entire supply for 24 hours be pumped in 4 hours? In case of a steam pump, if we have a pumper and the water supply is so situated that the pumper will do nothing else, it will require a larger plant to pump it for 24 hours than it would if it were supplied for longer hours.

Mr. Ransom: That recommendation was made so that a regular pumper would have a chance to pump one station and then go to another.

Mr. Loweth: Where water stations are far apart and train service frequent, one pumper cannot do more than attend to one station.

Referring to the table of number of strokes per minute, etc., for power pumps, Mr. Ransom said that since this report was made up, there had been some criticism of the speed. The table was a recommendation from a man who has been in the pumping business a good many years, and the committee felt possibly it was a little too conservative. It was also felt that a similar table regarding deep well plants required more investigation before being published in the Manual. The two tables were therefore referred back to the committee for further report next year.

The paragraph concerning pump houses was read.

Mr. Lindsay: I suggest this be altered to read: "stoves and lights shall not be permitted in the house," and also that a statement be inserted that the gasoline supply shall be kept out of the house.

Mr. Ransom: If a man has to run his engine at night he has to have some light, to see whether his oil cups are full.

Mr. Lindsay: We put our lamp outside so that it throws the rays of light inside.

Mr. Ransom: The committee will accept that.

L. C. Fritch (I. C.): A fireproof pumping house should be

isolated and not incorporated with another plant. If it is incorporated with some other plant the moment the other plant catches on fire the pumping house may be destroyed.

Mr. Ransom: The thought of the committee was that where you have a steam plant, and already have steam in your shop, in order to prevent loss by condensation you would want the pumping plant as near the steam supply as possible. You would not want to maintain separate boilers for the pumping plant.

Maurice Coburn (Vandalia): It seems to me that the question of steam turbine with centrifugal pumps, should be considered.

Mr. Ransom: The steam turbine question has not come up at all. We have no knowledge where any plant of that character is located for railway use.

The specifications for 50,000 gallon tubs were read.

Mr. Ferriday: Since the report was published, we have looked further into the question of the measurements and would like to substitute the word "outside" for "inside." The conclusion would then read: "The outside diameters shall be 24 ft. at the bottom and 23 ft. 4 in. at the top. The staves shall be 15 ft. 11 in. long." We are also going to change the specifications to show specifications for about a 48,000 gallon white pine tub. They are spoken of as 50,000 gallon tubs, but the capacity is really less.

A. K. Shurtleff (C., R. I. & P.): Why is there a different diameter for the bottom and top of the tub? I have known for a number of years of tubs being successfully used of the same diameter throughout.

Mr. Ferriday: These dimensions conform with the majority of tubs as built. The tubs are tapered because hoops were originally driven on.

Mr. Shurtleff: I have found the manufacturers are willing to bid on a straight tub. There is no trouble about getting competition, and I cannot see why we should bind ourselves to what the manufacturer might wish to deliver.

J. P. Berry (C., R. I. & P.): We have been building water tanks with straight staves for twenty years. It does not cost much more money to increase the capacity of the tub. Simply because some man has been doing something for a number of years back, does not compel us in a modern plant to adopt these ideas, because a manufacturer wants it so.

Mr. Ferriday: We shall be glad to have recommendations to change that. The majority of the tubs, I believe, that are being furnished are in accordance with the dimensions. That was the reason they were selected, not to recommend something different from those usually furnished.

Mr. Shurtleff: I move that the specification for 50,000 gallon white pine tubs be changed to read "the inside diameters shall be 24 ft.," leaving out the question of bottom and top.

W. F. Steffens (C. C. & O.): I hope we may open the argument as to the relative merits between a 50,000 gallon tank and a 60,000 gallon tank. A 60,000 capacity tank is secured by increasing the height of the staves 4 ft.; in other words, we add 20 per cent capacity at a relatively small cost.

Mr. Ferriday: It was not recommended that this size be used, but it was recommended that those specifications be used for that size tub. Nor was it intended to recommend white pine tubs, but it was intended to recommend for 50,000 gallons white pine tubs these specifications be used.

Mr. Shurtleff's amendment was adopted.

J. P. Snow (B. & M.): Paragraph "d" says that the hoops shall be provided with pressed steel lugs. I think this would require flat hoops, and if so, it should be modified so that either flat or round hoops could be used.

Mr. Ferriday: The hoops on the recommended plan are flat. The committee in their report state that the use of the half-round or semi-elliptic hoop might be considered special shapes that were not ordinarily obtainable, and they felt by recommending the use of the muck bar wrought iron hoop, together with heavier hoops, that a sufficiently strong hoop would be provided. The lugs were recommended in connection with these flat hoops.

Mr. Loweth: I think this association ought not to go on record as approving flat steel hoops, or flat iron hoops, as against round hoops. For four or five years past we have been making more or less extensive use of round hoops on our tanks and the round hoops are now standard. Our experience in the past has shown it has many points of advantage over the flat hoop.

J. O. Osgood (C. of N. J.): We have also been using round hoops as standard for several years.

C. H. Ewing (P. & R.): We have adopted the round iron hoops as standard and do not consider it safe to continue to use the old flat hoops, in view of the failures we have had on that account.

Mr. Lindsay: I move the subject of tank hoops be referred back to the committee for further consideration.

The motion was carried.

Mr. Fritch: It seems that paragraph "f" should go back to the committee with paragraph "d."

Mr. Shurtleff: I move that the entire specification for white pine tubs be referred back to the committee with the idea of leaving the dimensions blank in such way that the specification will cover any dimension of white pine tub that is used in practice.

M. L. Byers (Mo. P.): I move to amend it by asking the committee to also prepare specifications for a 100,000 gallon tank.

Mr. Shurtleff: I think my motion would cover the 100,000 gallon tanks as well as the 60,000, if the committee eliminate dimensions, covering the specific points for wood tubs of any capacity.

Mr. Loweth: I should be sorry to see Mr. Byers' amendment carried, because I feel that a wooden tub of 100,000 gallons capacity is too large. When we want such a large capacity tank, we should go to steel.

Mr. Byers' amendment was lost.

The motion of Mr. Shurtleff was carried.

Mr. Lindsay: I think after tub unit capacity would be a good place to put in that the tub capacity for 24 hours should be of such capacity as to be pumped by the day or night shift. We find we can effect considerable economy by increasing our tub capacity, so that one pumper can pump enough to last through the night.

Mr. Ferriday: We say that the tub unit capacity at terminals depends on the relation of consumption, cost of installation and operation, and it seems to me this covers that feature. If, from the operating cost standpoint, it is more economical to make the tub unit capacity large enough to avoid pumping at night, then the capacity should be large enough for that purpose.

Mr. Osgood: I notice the following: "It is recommended that the unit be at least 50 per cent greater than the maximum daily consumption when erected." In the case of a consumption of 500,000 gallons a day or more, that is a little severe.

Mr. Ferriday: I think that for intermediate water stations, to which that section applies that consumption would not very often occur. The idea of the committee is that in a large consumption of that kind it would probably be at a terminal station.

Mr. Osgood: I have in mind a case where about 700,000 gallons daily are taken. I think the phraseology might be more elastic, so as not to seem to require for good practice so large an excess over the daily consumption.

Mr. Loweth: In line with what Mr. Osgood has suggested, I suggest that the last sentence of the first paragraph be made to read: "It is recommended that the probable future requirements shall be considered." That is a caution against putting in a station that is too small, and avoids being so definite as to state that not less than 50 per cent reserve capacity shall be provided.

Mr. Lindsay: We have a track tank which furnishes in the neighborhood of 900,000 gallons of water. It is a 50,000 gallon tank and supplied by a duplicate system of pumps, so that if we followed the committee's rule we would have a pretty large storage capacity.

Mr. Ferriday: Mr. Loweth's suggestion will be accepted. We had in mind an intermediate water station consuming from 50,000 to 100,000 gallons a day. We withdraw the entire second sentence in paragraph 2, relating to tub unit capacity at terminals. The sentence begins "The unit capacity in this case," etc.

Mr. Osgood: Under Water Columns, it is stated that "Supply line should be same size as column where distance to storage tank is not over 100 feet; where distance is greater, one size larger is recommended." We have found it good practice in our case to do away with 12 in. spouts and substitute 10 in., using a 12 in. supply line. The 12 in. spout is very heavy to handle and the delivery is practically the same with the 10 in. spout, provided the supply line is kept at 12 in.

Mr. Ferriday: Do you do that where the distance is 100 feet?

Mr. Osgood: We always put a 12 in. line from the tub to the stand pipe, and now use a 10 in. stand pipe.

Mr. Byers: In connection with Tub Unit Capacity, I would like to suggest to the committee the value of a table which would show the comparative cost of securing tub unit capacity by sizes of tub as compared with number of tubs. I think any of us who have not figured that out would be surprised

at the slight increase of cost of the 100,000 capacity tank over the smaller tanks.

The President: The committee will take cognizance of that.

Mr. Lindsay: It is stated under Operation that "a traveling repair man should visit each plant periodically and attend to all repairs which cannot be made when plant is running." Does that mean "which cannot be made by pumper or man in charge?"

Mr. Ferriday: Yes.

Mr. Osgood: Has the point of duplicate pumping machinery been considered?

Mr. Ferriday: A recommendation is in the body of the report, but does not appear in the conclusions. We recommend where a pump has to run twenty hours in order to supply the quantity of water desired, that duplicate machinery should be added. I think that should be added in the conclusions.

Mr. Loweth: What is to be gained by the association committing itself to the first sentence of the first paragraph under Operation? We have many water stations on the St. Paul which are taken care of by men whose principal business it is to do something else; they may be helpers about the station. Many of our gasoline pumping plants are taken care of by the station force, and although the plants run for long hours the amount of care and attention given to them by the station force is relatively small as compared with their other duties. This is also true in some of the larger terminals.

Mr. Ferriday: Has Mr. Loweth kept a correct record of the repairs on the line?

Mr. Loweth: Yes.

Mr. Ferriday: We have found from what information we can get on that subject from members that the repairs would run up pretty heavily where the men had some other duties to perform.

Mr. Byers: I agree with Mr. Loweth, but would add the second sentence also. I think it is desirable to have the pumpers who are regular men make all the repairs they possibly can. Further, there are many repairs that cannot be made by traveling repair men. We must send the boiler to the shop to have it repaired. I would prefer to see both sentences stricken out and will make a motion to that effect.

Mr. Ferriday: The idea of the first part of the conclusion is this:—in a great many cases the men who want to sell the gasoline pumping engines tell about how little the labor cost will be, and the pump is purchased and put into operation and it runs for awhile and then it commences to go all to pieces. I know from the operation of gasoline engines in running dynamos at electric interlockings that the attendance of a man is necessary, because if anything goes wrong the engine runs away with itself. It makes it expensive to repair it, and it also interferes with the supply which is very important to be continuous.

The idea of putting in the second sentence was that repair men should visit the plants periodically, not that he should make all of the repairs, but that periodical visits should be made by expert repairmen and in that way the maintenance of the plant will be kept to a high standard.

Mr. Lindsay: I think it is a mistake to put a steam plant in the hands of a baggage man or station attendant, who is not qualified to operate it. I think the recommendations are proper and this association should go on record as being opposed to having a pumping plant in charge of a man who is not competent to run it and whose chief business is not the operation of the plant.

Mr. Ferriday: The idea was that the pumper should be put on this work and his spare time put on other work.

Mr. Loweth: It doubtless costs more for maintenance in a pumping plant if it is taken care of by a man whose particular business may be something else, but it costs a great deal to take care of a pumping plant, taken care of by an incompetent man, whether he puts part or all of his time on it. On the St. Paul, many pumping plants are taken care of by station helpers, for which they are paid from $7.50 to $10.50 a month, that amounts to from $90 to $120 a year. Our pumping plants are occasionally expensive to maintain on account of the inefficiency of these men, but such plants could be renewed, so far as the engine is concerned, entire, for something like $500 or $600 and the repairs needed are nearly as great as the economy by having the men do the pumping in addition to other duties.

L. R. Clausen (C., M. & St. P.): I object to that paragraph, for the reason that it lays down principles for operations for all conditions. The principle may be perfectly proper for a road with congested traffic where your pumping stations furnish a large amount of water, but does not apply on a road where there is thin traffic and the stations are not required to furnish a great amount of water. I do not think it good policy for the association to advance or define a particular principle to cover all conditions. If you want to define a policy, make some distinction in the conditions. If I followed the policy outlined here, it would make an addition to our operating expenses which is not justified, because we are furnishing water satisfactorily by using employes whose principal duties are other than that of pumping.

The first section under Operation was stricken out.

M. J. Henoch (L. & N.): Has the subject of reinforced concrete tanks been considered? If not, I move that the committee be requested to investigate and report on the subject.

Mr. Ransom: The subject has not been considered, because we have not been able to find any that have been built.

Mr. Hanna: I have not any particular information on the subject, but I have noticed reports at different times in engineering periodicals of reinforced concrete tanks that have been built at various points.

The committee's report, as amended, was adopted.

SIGNS, FENCES, CROSSINGS AND CATTLE-GUARDS.

The following subjects were assigned by the Board of Direction:

(1) Present such additional recommendations and conclusions covering the various subjects reported on in the previous reports of the committee as may be considered desirable.

(2) Report on snow fences, snow sheds and other means to prevent snow accumulating and best methods of clearing tracks and snow removal.

(3) Report on the use of concrete fence posts, results obtained so far in actual service, designs and cost.

The first subject was assigned to the entire committee; and the second and third to sub-committees.

Additions to the Manual of Recommended Practice.

Your committee submits the following for approval and addition to the Manual of Recommended Practice under the head of "Gates for Right-of-Way Fences":

The width of farm gates should be from 12 to 16 ft., depending upon the size of agricultural machinery in use in the vicinity. The minimum height of farm gates should be 4 ft. 6 in. from the surface of the roadway.

Farm gates should be hung so as to open away from the track, and, if hinged, to swing shut by gravity.

The Proper Construction of Grade Crossings.

Owing to the well-known difficulty of maintaining the track in proper surface through and adjacent to grade crossings, a form of construction should be adopted that will tend to remedy this trouble by requiring a minimum amount of labor and material to be expended in repairs or renewals.

This construction will necessarily vary with conditions, but can be divided into the following general classes:

(1) Crossings where paving is required to conform to street specifications. (2) Crossings of streets where no paving is required. (3) Crossings of public roads or highways outside of towns or cities. (4) Crossings of private or farm roads.

(1) For crossings where paving is required to conform to street specifications, cross-ties should be treated chemically to prolong their life to the greatest limit possible, and laid on a bed of stone or slag ballast, not less than 12 in. in depth, placed in 3 in. layers, each thoroughly rammed so as to prevent settlage. An 8-in. bed of Portland concrete mixed 1-3-6 can be substituted for the ballast if desired.

With the ballast and outside of the tracks, porous tile drains not less than 6 in. should be placed at intervals, leading to the nearest point from which efficient drainage can be obtained.

The support of the rail on the ties will vary with the character of paving used.

If stone blocks are used, a substantial cast or malleable steel chair, with a base of not less than 48 sq. in., should be provided, fastened to the tie with suitable lag-screws, the rail fastenings to be a hook-headed bolt secured with nuts. Ties should be spaced so as to allow the joints to be supported by these chairs.

On long stretches of track laid in streets paved with stone blocks, the use of a special rail section, not less than 9 in. in depth, is advisable, to avoid the use of the chairs mentioned; with such a rail, heavy tie-plates should be used as a protection.

On the outside of the rail, the block paving should be laid up to the rail-head, but left slightly below it on the inside. An old rail or a suitable form of rolled filler should be placed to provide a flangeway, this to be fitted into the space between the head and base of the track rail; if an old rail is used the flange should be placed as nearly vertical as possible, the paving between the rails to be limited by the flanges or fillers. The flangeway should be supported by the same chairs carrying the track rail, with a clear opening of not less than 2 in.

Where a special rail section is used, the flangeway should be rolled as a part of it.

With vitrified or paving brick, the ties should be similar and have the same foundation as described above, except that with rails of high section the use of the cast chairs is unnecessary.

A heavy tie-plate should be placed on each tie where the ordinary track rail is used.

A strip of treated timber 4 in. x 6 in., fitted to the rail and placed so as to expose 3 in. of surface next to the rail-head, should be used next to the outside rail, and this should be paved against; the strip should be ¼ in. below the rail-head.

Metal flangeways should be provided as described above, and paved against in like manner.

With asphalt paving a similar construction as for vitrified brick is recommended.

Paving between and outside of the rails should be laid in the most approved and workmanlike manner.

(2) Street crossings where no paving is required should be divided into two classes—those with plank laid the entire width and length, and those with plank only next the rails and at the ends and filled between with suitable material.

For the first style, the plank should be of such timber as can be most economically obtained, not less than 3 in. in thickness, the outside planks to be shimmed, so as to be ¼ in. below the rail-head, and those inside similarly shimmed when necessary.

An old rail laid on the side of some suitable form of rolled metal shape should be used as a flangeway, its ends to be slightly bent inward, so as to give an opening of not less than 4 in. at the ends, the flangeway through the balance of the crossing to be not less than 2 in.

The intermediate planking should be closely fitted to the base of the old rails or other metal forming the flangeway, so as to avoid the necessity of further securing them to the ties.

For fastening the planking to the ties, ⅜ in. x 8 in. cut spikes should be used for rails 5 in. in height and under.

The ends of the planking should be beveled both between and outside the rails to a thickness of 1 in., commencing at a point 10 in. from the end.

One plank not less than 10 in. in width should be used on the outside of the track rails, and the total length of the planking should conform to the required street width.

Concrete, slag or other suitable material should be used from the plank outside of the rails to such distance necessary to properly complete the crossing.

Where the requirements do not call for continuous planking over the tracks, one plank should be placed each side of each rail, with the flangeway rails or metal shapes as described above and similar in other details, with the exception that a filling of concrete, slag, gravel or other suitable material should be used between the planks, the material to be filled in level with the top of the planking after a thorough compacting.

In the description of street crossings for cities and towns, no limits as to approach grades are given, such physical characteristics being governed by local laws and conditions. The width of the street crossings are also governed by local requirements.

(3) For public roads and highways outside of towns and cities, the crossing construction should be similar to that described for streets which have the minimum amount of planking and ballast filling between them. Such crossings should be level for a distance of 5 ft. on each side of the outside planks; on a fill, the approach grade should not exceed 6 per cent.

Where the crossings are in a cut, the ditch drainage should be provided for by the use of terra cotta pipe where feasible, but if the volume of water is too great, box culverts or bridges of similar width to the crossing should be provided.

The width of highway crossings should be not less than 16 ft.

(4) Crossings of farm or private roads should be constructed by filling with ballast or other suitable material level with the rail-head, on the outside and inside, leaving a proper flangeway inside the rails. Such crossings should be level for not less than 3 ft. each side of the rails, and the approach grades should not exceed 8 per cent.

In cuts, proper provision should be made for drainage as for highway crossings.

The width of farm or private road crossings should be not less than 12 ft.

Protection Against and Removal of Snow.

SNOW FENCES.

[The committee briefly described and showed plans of various devices for protection against snow, received in response to a circular letter. These include permanent snow fence, portable snow fence, hedge fences, stone walls, earth mounds, and old tie fences.]

It is the common practice on many railways to give shallow cuttings a very flat slope, usually 1 to 4; in several cases as flat as 1 to 10 slopes are used. These snow slopes have the effect of allowing the wind carrying the drifting snow to pass through the cutting and over the tracks without causing an eddy in the wind, and prevent accumulation of snow on the track.

WIDENED CUTTINGS.

A very successful method has been adopted on many railways to escape snow accumulating in deep cuttings by borrowing material which they require for widening banks, filling trestles, etc., from the sides of cuttings into which snow had been drifting. A steam shovel cut on the windward side has been sufficient to give ample space for the drifting snow to accumulate and keep clear of the tracks. In this connection it is interesting to note that snow seldom accumulates in rock cuttings that are 25 ft. or more in depth. In these cases the precipitating snow seems to be blown out of the cuttings by deflected air currents.

SNOW PLOWS.

Rotary and wedge or push plows are in general use. The latter placed ahead of the locomotive are effective in removing snow up to 6 ft. or 8 ft. in depth when the drifts are not too long. The number of locomotives required to operate a wedge or push plow depends upon the condition of the snow, its depth, and the grade and curvature of the railway. On some railways, where the amount of snow to be handled is not great, efficient service is secured by means of a snow plow on the pilot of the engine. They vary in height from 2 ft. to 6 ft.

A flanger is a small snow plow arranged to raise and lower mechanically. When used on locomotives they are operated from the engine cab by air or steam, and are very effective in countries of light snowfall when used in conjunction with the pilot plow. Flangers are also constructed on freight train cabooses and are operated by the trainmen.

Some roads have special flanger cars which are run on the rear of trains, operated by special crews. This method is probably less dangerous than in the case of flangers on the locomotive.

SALT AT SWITCHES.

Most railways use salt to keep ice from forming at switches. The use of salt at interlocking plants, however, is usually prohibited. The method usually adopted of clearing snow from yards is by means of shoveling into cars and dumping at convenient points. The Canadian Pacific reports the removal of snow from divisional yards by means of wing plows, whereby the snow is thrown from track to track until it is clear of the entire yard. Ballast spreaders and rotary snow plows are frequently used for this purpose. The New York Central reports one division using compressed air from the locomotive to clean switches of snow.

Experiments are being made for the melting of snow by means of steam pipes in the valleys of train sheds and shop buildings, but thus far the process has proven slow and expensive.

In the colder countries considerable difficulty has been encountered from the formation of ice along the eaves of flat-roofed engine houses. This difficulty is being overcome on the Canadian Pacific by an air space on top of the masonry wall and the eaves sloped at an angle of one to one.

At wayside water tanks the accumulation of ice on the track is prevented on the Canadian Pacific by the extension of the exhaust pipe from the pump, whenever it is located within or near the tank.

SNOW SHEDS.

Snow sheds are used by a number of railways where they cross the mountains in the West. Most of these sheds are designed to carry snow slides over the tracks without blocking them, and a few to protect against the level fall of snow. These sheds are usually made of heavy timbers. They are generally effective, the only objection being their cost of construction and maintenance and the liability of being destroyed by fire.

RAILWAY LOCATION.

In the location and construction of railways through snow country special attention is given by the locating and construction engineers to provide against difficulties in the operation of the railway on account of snow. An embankment 2 ft. above the surface of the ground is generally sufficient.

Snow slides in mountainous country are given full consideration and, if possible, the railway is located either to avoid them or to provide for an economical snow shed construction. In some cases the railway has been carried over snow slides, which occur in ravines, by means of spans. This method, however, proved disastrous in a number of cases, as the spans were carried out or wrecked by the large trees that were brought down with the slide.

CONCLUSIONS AND RECOMMENDATIONS.

Snow Fence.

Snow is carried by the wind close to the surface of the ground and is deposited in railways cuts on account of the eddies which these cuttings cause in the wind. The function of the snow fence is to form artificial eddies on the windward side of the cut at sufficient distance to cause the snow to deposit between the snow fence and the cut.

The location of the drift or eddy depends upon the form of the fence. A tight fence of sufficient height will cause the snow to accumulate on the windward side of the fence; an open fence causes the snow to accumulate principally on the leeward side. The distance between the fence and the drift depends upon the height of the fence, the width of the openings between the boards, the velocity of the wind and the character of the snow.

The character of the snow fence and its location for the protection of a given point depends largely upon local conditions, some of which can only be determined by experiment, and for this purpose portable snow fence is recommended. Where local conditions admit, a permanent snow fence located on the right-of-way fence line is most economical.

If permanent wooden fences are used, the boards should be laid close, where the right-of-way is 50 ft. or less from the center of the track; for greater distances space should be provided between the boards, and at 100 ft. distance, 50 per cent of the fence should be open space. The height of permanent board fence depends upon the probable amount of snow. The maximum height, however, should be 10 ft.

In most cases local conditions require the use of a portable snow

fence. These fences are usually erected in the fields adjoining the right-of-way. They should be set on the windward side of the track at right angles to the prevailing winds and, to provide for variations in the direction of the wind, it is sometimes necessary to set the panels in crescent form. For ordinary conditions one line of fence is sufficient. The quantity of snow sometimes requires the use of three or four lines of portable snow fences set parallel and spaced about 100 ft. apart. These fences should be removed in the spring so as not to interfere with farming operations.

Hedge fences should be used where the quantity of snow is not too great, and where local conditions, including the economic feature, admit. Properly maintained hedge fences are effective in beautifying the right-of-way.

Stone walls should be used for snow fences where suitable stones for dry masonry walls are delivered free to the railway company by the adjoining property owners.

Temporary snow fences should be constructed of ties, laid in the form of worm fences.

Miscellaneous Methods.

Railways constructed in Northern countries should have the track raised about 2 ft. above the general level of the ground, and for cuttings less than 4 ft. A flat slope of 4 to 1 should be given to both sides of the cutting.

In construction of new railways, or in grade revision, or trestle filling on existing railways in snow districts, the material should be taken from the sides of the cuttings. A steam shovel cut on each side is most effective in providing a place for snow to accumulate for ordinary snow conditions for cuttings up to 20 ft. in depth.

Salt should be used on switches only during that portion of the winter when the snow melts in daytime and freezes at night.

Where exhaust steam is available it should be carried about 12 in. beneath the surface of the ground at points where the accumulation of the ice requires frequent removal during the winter.

Snow Plows.

Rotary snow plows are necessary for quick removal of snow where the depth of the drift exceeds 6 ft. and its length exceeds 30 ft., or where the natural snowfall has filled deep cuttings which the push plow cannot remove. Rotary snow plows are sometimes used to advantage in the removal of snow slides in mountain districts.

Push plows should be used for a level fall of snow and minor drifts, whenever the depth is too great to be removed by snow flangers. Snow flangers should be used for the removal of snow whose depth is less than 6 in. over the top of the rail.

Snow Sheds.

Snow sheds are expensive to construct and expensive to maintain, and the railway should be located, if possible, so as to prevent the necessity of their construction. Their use should be confined to localities which require protection from mountain snow slides, and then they should be constructed of more permanent material than is now ordinarily used.

Concrete Fence Posts.

From observation of concrete fence posts your committee considers that the concrete post will heave very little or not at all, as posts set from two to five years ago are at present in almost perfect alinement, and not a loose or broken post was found. They appear sufficiently strong for all practical purposes after being properly cured and set. The claim that concrete posts reinforced with steel form lightning protectors appears reasonable. They will, of course, resist the action of fire and decay. They will not float and cannot be displaced so easily as wood posts. On the other hand, concrete posts must be carefully handled in loading and unloading and well cured before using. Fence wire in contact with their surfaces should be well galvanized. The concrete post is much heavier than the wood post and the cost of distributing and setting is about 25 per cent greater.

It would seem that the concrete post is particularly adapted to railroad use. Most of the post machines are cheap and portable and the materials used are in daily use on all roads using concrete; the materials are cheap and easily obtained.

Your committee corresponded with over 20 manufacturers of posts and postmaking machinery in the United States and Canada. A majority of these firms use or advise the use of Portland cement and gravel varying from the size of sand to pebbles which will pass a wire screen having meshes of from ½ to 1 in. sq. The ratio of cement and gravel is as 1 to 4. The methods of reinforcing and tamping concrete posts vary almost as much as those of fastening the fence wire to the posts. The machines are of various capacities and design—from the one-post hand mold to the "post per minute" power machine with continuous mixer attachment. The average total cubic content of the 7-ft. post is 0.825 cu. ft.; of the 8-ft. post, 0.95 cu. ft. The weights vary from 65 lbs. to 95 lbs., according to methods of manufacture and reinforcement used. Concrete posts retail for from 25 to 35 cents per post. End and gate posts are of about three times the volume and cost of intermediate posts. In section, concrete posts vary from square or rectangular to triangular, half-round and circular. Reinforcements are of wire, wood, strap steel, steel and wire truss, wood and wire truss, chain scrap strips and expanded metal. Fence wire fastenings are also of various forms—from the wire loop around the post to the patent staple encasement. All the posts observed taper from a smaller top to a larger base. Some have very wide concrete block bases.

In response to invitations sent to all manufacturers four concrete post machine firms demonstrated their machines at Bay City, Mich., making 12 reinforced concrete posts each, which were tested at the Michigan Agricultural College.

These posts were tested for tensile strength; panels were erected to test the holding power of the fence in place as well as give the set posts impact tests and, if possible, to compare their strength of resistance to impact with wooden posts. They were tested in a machine of large capacity, 42-in. span, both ends supported, load applied in center. The following results were obtained at an average of seven to twelve posts of each sort so tested:

Name of Mfr.	First crack.	Maximum wt. post broken.	Deflection in inches.
D	458 lbs.	1,090 lbs.	0.68
B	648 lbs.	1,071 lbs.	0.70
A	564 lbs.	1,020 lbs.	0.53
C	927 lbs.	1,356 lbs.	0.66

The comparative results show the importance of thorough tamping and stiff reinforcement near the surface of the post. A cedar post of dimensions identical with the average of these concrete posts would weigh about one-fourth as much and be four times as strong. The results in practice show that the wood posts used are much stronger than necessary rather than that concrete posts are not strong enough.

Conclusions.

Your committee recommends the adoption of the following conclusions for publication in the Manual of Recommended Practice:

(1) That the recommendations under Farm Gates be approved as good practice.

(2) That the recommendations as to Construction of Highway Grade Crossings be approved as good practice.

(3) That the recommendations as to Snow Fences, Snow Sheds, Flangers, Snow Plows, etc., be approved as good practice.

(4) That the recommendations as to Concrete Fence Posts be approved as good practice.

The report is signed by W. D. Williams (C. N.), Chairman; F. P. Gutelius (C. P. R.), Vice-Chairman; A. G. Boughner (B. & O.); A. E. Doucet (Trans. Ry.); A. M. Funk (B. & O.); Paul Hamilton (C., C., C. & St. L.); C. W. Johns (C. & O.); S. A. Jordan (B. & O.); H. L. Laughlin (M., St. P. & S. S. M.); E. R. Lewis (M. C.); M. A. Neville (P. & E.); P. Petri (B. & O.); K. J. C. Zinck (G. T. P.).

Discussion.

L. C. Fritch (I. C.): In fixing the height of farm gates, did the committee take into consideration the laws in various states with respect to what constitutes the legal fence?

Mr. Williams: They did, and we consider that height will come nearer with complying with the laws of all the states than any other.

The secretary then read conclusions 1 and 2.

C. H. Ewing (P. & R.): In the recommendation as to highway crossings, I notice the flangeway at the crossings is given as 2 inches. It is our practice to use 2½ inches.

Mr. Williams: The committee considered 2 inches about the proper clearance. We make it 1¾ for our guard rails, and there is no reason why the crossing should be wider, but there was a good reason why they should be as close to the rail as practicable on account of keeping animals from getting caught in the rail in the crossing.

Mr. Ewing: Where we have trolley crossings at grade with a flangeway necessary for the crossing frogs, we have been forced to narrow it from 2½ inches to 1¾ inches to conform to our standard crossing. During the past winter there have been several accidents on the crossing where there was a 1¾-inch flangeway, particularly when the horses are shod with very long corks. The corks become wedged under the rail. In one case, even with cast iron fillers in the crossing, an animal was wedged so that it was necessary to get a bar to pry it loose. We do not have that trouble to a very great extent where the flangeway is 2½ inches.

E. F. Wendt (P. & L. E.): I move that the four conclusions of the committee be approved by the convention, with the understanding that the detailed recommendations referred to by the conclusions be reduced to a statement of principles.

G. A. Mountain (Can. Ry. Comm.): I notice that the conclusion states that farm gates shall be 12 to 16 feet. The law in Canada is that no farm gates shall be less than 14 feet, and in the prairie 16 feet. We find farm implements used in the eastern provinces that will not go through a 12-foot gate.

C. S. Churchill (N. & W.): Since the conclusions include the point Mr. Mountain raised as to farm gates, it seems to me it would be well to add a clause in the recommendations,

namely, "or as required by the laws of the states through which the railway may pass."

Mr. Williams: The committee will accept Mr. Churchill's recommendation.

C. H. Stein (C. of N. J.): I have in mind a point where the flangeway is 1⅞ inches, which approximates the 2 inches you have specified in your report. I know of at least 25 accidents that have occurred at that crossing, where animals shod with what they call the "never-slip toe piece" have become wedged, resulting in considerable damage costs. I think there ought to be some latitude for railways to use 2½ inches opening if they find it expedient. I offer as an amendment to the report that it be made not less than 2 inches and not more than 2½ inches.

Mr. Fritch: Some lawyer in a suit might get hold of these proceedings and would point to the fact that "here is an association that points out that 2½ inches is the maximum width allowable." We might get into serious trouble. It seems to me the committee has put this in a very safe way in saying not less than 2 inches.

W. M. Camp (Ry. & Eng. Rev.): I think if the space beneath the head of rail is blocked solidly accidents would be avoided.

Mr. Ewing: At the place where the accidents to which I referred occurred, there was a steel filler the entire length. The width of the flangeway is an important matter and might lead us into considerable trouble. We have been called upon twice this past winter to get testimony from other railways as to their width of flangeway. The question has been raised in court in two of our suits, and we had to produce evidence in support of the width which we maintained. The Pennsylvania Railroad, I understand, are using the same width of 2½ inches.

Mr. Stein's amendment was defeated.

Mr. Wendt's motion that the conclusions be adopted, with the understanding that the details to which they refer be modified, was carried.

ROADWAY.

The following sub-committees were appointed:

(A) Track Elevation and Depression. (B) Waterways. (C) Washouts, Drainage and Curing of Slides. (D) Surface and Sub-Surface Drainage and Tiling of Wet Cuts. (E) Special Sub-Committee to Report on Use of Specifications.

The Board of Direction assigned the following subjects:

(1) Continue the consideration of track elevation and depression inside of cities, and grade and curve improvement work outside of cities, and submit recommendations covering more particularly questions of detail relative to the handling of the work.

Supplementing its last report on the subject of track elevation work inside cities, your committee presents in Appendix A some further discussion on this question.

In connection with the subject of track elevation and depression, it has seemed desirable to your committee to make a compilation of the laws of the several states relating to the question of separation of grades. This compilation will appear in a future Bulletin and in the Proceedings. A summary of the laws is given in Appendix A.

(2) Report on the best method for determining the size of waterways.

In Appendix B your committee submits the result of its labors on this question.

(3) Report on the protection of the roadbed in embankment and excavation from the action of water, more particularly with reference to protection from washouts or overflows and from slides, whether caused by surface or underground water.

On the subject of slides and washouts, your committee presents in Appendix C a digest of interesting and instructive replies to a circular of inquiry, treating of various phases of the subject, from members of the association and others, in the graphic language of their authors, who include 25 engineers from as many different roads.

(4) Report on the surface and sub-surface drainage of embankments and excavations.

(5) Report on the tiling of wet cuts and the curing of slides.

The report on these subjects is given in Appendix D.

Track Elevation and Depression.

The committee presented a description of a typical organization and method of handling track elevation work, prepared by F. L. Stone, Engineer of Track Elevation of the Chicago, Burlington & Quincy.

In addition to the summary of the compilation of laws of the several states relating to grade separation, there is a summary of grade crossing elimination work done or under way in the United States, arranged by cities.

Best Method for Determining Size of Waterways.

Following quotations from Wellington and Myers regarding the economic basis of culverts in this appendix, there is a comprehensive statement relative to the several ways in general use for determining the proper size of waterways. prepared by the late Walter G. Berg.

There is a discussion of the several formulas in use—the Myers, Talbot, Dun and others, including the Burkli and McMath. Following this is a digest of current practice made up from replies to a circular of inquiry sent by the committee to members of the association, 27 writers being quoted at greater or less length.

Surface and Sub-Surface Drainage of Embankments and Excavations, and Tiling of Wet Cuts and Curing of Slides.

To attain efficient surface drainage:

(a) Surface intercepting ditches should be constructed on the up-hill side of all cuts where ditches may be opened without becoming the proximate cause of slides to the track.

(b) Open ditches should be constructed along and near the toes of the slopes of such embankments as rest upon soils which may become unstable if saturated for the purpose of intercepting and diverting from the surface upon which the embankment rests the water flowing toward the embankments.

(c) Occasionally drain pipe may be constructed along and near the toe of slopes of such embankments as rest upon soil which is unstable on account of saturation and where the open ditch of (b) will endanger the embankment.

(d) Open side ditches should be constructed in all cuts.

Your committee recommends that the minimum intercepting ditch be 1 ft. deep and 1 ft. wide on the bottom, with slope to suit the soil.

The minimum grade for intercepting ditches should be 0.30 per cent. If the grade of any ditch necessarily be so great that water flowing through it threatens quick destruction, paving may be necessary.

Side ditches should be provided in cuts whether the subgrade be in rock or earth. The minimum side ditch should be 1 ft. wide on the bottom and 1 ft. deep below subgrade, with slopes as adopted in article 5 of the standard specifications.

The minimum grade for side ditches should be 0.30 per cent. If the rate of grade of the track in any through cut is less than 0.30 per cent., the cut may be widened to permit side ditches to be constructed on 0.30 per cent grades, or drain pipes may be laid to proper grades below the ditches and to any available outlet.

Your committee does not favor open side ditches in tunnels, but suggests some method of pipe drainage.

Your committee regards the cleaning out and repair of intercepting ditches and side ditches in cuts as a necessary feature of the maintenance of way.

The roadbed when made of clay in embankment should often be altered when reballasting by cutting the shoulder down outside the ties to allow thorough drainage of the depressed ballast and a new shoulder formed of porous material.

Efficient sub-drainage of wet cuts and of saturated soil upon which embankments rest may be attained by the use of pipe drains.

Pipe drains should be constructed for the quick discharge of such surface and underground water as it may not be practical to intercept. The pipe should be laid with the track and immediately below the center of the side ditch in cuts and about ten feet from the toe of slopes of embankments, and on grades of not less than 0.20 per cent.

Care should be taken to locate the pipe at such depths that no displacement will be made in the alinement of the tile by the subsidence of the roadway under traffic. To this end the trench in which the tile is to be laid should be dug down into a motionless strata underlying the saturated material which it is desired to drain. The trench above the pipe should be completely filled with cinders or other porous material which filters the water and aids its passage to the pipe and prevents the intrusion of the saturated material under pressure of traffic.

A water pocket beneath track may be drained by small cross drains laid in cinder-filled trenches, or by trenches filled with cinders, gravel or similar material.

Your committee recommends that no pipe be used with an inside diameter of less than 6 in., except for cross drains.

It will rarely be necessary to use sizes larger than 12 in. inside diameter. The pipe should be hard burned, but not necessarily salt glazed. The trench into which the pipe is laid should not be made larger than necessary for the economical digging of the trench and laying of the pipe.

Conclusions.

Your committee recommends the adoption of the following conclusions as recommended practice:

WATERWAYS.

(1) In determining the size of a given waterway, careful consideration should be given to local conditions, including flood height and flow, size and behavior of other openings in the vicinity carrying the same stream, characteristics of the channel and of the watershed area, climatic conditions, extent and character of traffic on the given line of road and probable consequences of interruptions to same, and any other elements likely to affect the safety or economy of the culvert or opening.

(2) (a) The practice of using a formula to assist in fixing the proper size of the waterway in a given case is warranted to the extent that the formula and the values of the terms substituted therein are known to fit local conditions.

(b) Waterway formulas are also useful as a guide in fixing or verifying culvert areas where only general information as to the local conditions is at hand.

(c) The use of such formulas should not displace careful field observation and the exercise of intelligent judgment on the part of the engineer.

(d) No single waterway formula can be recommended as fitting all conditions of practice.

SLIDES.

(1) Every slide should be considered as a problem by itself.

(2) The cause of the slide should be sought. The removal or prevention of the cause is as important as the restoration of the roadway.

(3) Piles or retaining walls for the prevention and cure of slides are not recommended; but their use is permissible for temporary repairs and in special cases.

(4) Underground water if present should be drained away or intercepted before it reaches the slide.

(5) The surface of the slide and the restored roadway should be graded so water will run off and not lie in pools. The surfaces may be compacted or sodded.

(6) The flattening of the slope is the most economical and permanent method of curing a sliding embankment.

(7) The removal of the material is nearly always the most economical and permanent method of curing a slide in excavation.

(8) A relocation of the line is sometimes necessary where the slide takes the proportions of an avalanche.

WASHOUTS.

(1) The ends of trestles and bridges should be protected with riprap or by other efficient means.

(2) Main track should be raised above height of flood waters and carried on strong and stable roadbed, so that it will not be subject to overflow.

(3) The track on an embankment subject to overflow should be ballasted with heavy angular ballast and anchored, and the lower slope of the embankment is sufficient to carry protected with riprap.

(4) On bridges subject to overflow the track should be anchored.

(5) If the velocity of the water carries away the riprap or other protection against scour, the width of the opening should be increased.

(6) If track is washed out temporary repairs should be made by filing in, cribbing or driving piles, to be followed by the permanent restoration of the roadway.

SURFACE AND SUB-SURFACE DRAINAGE AND TILING OF WET CUTS.

(1) All the water possible should be kept off the roadbed.

(2) Surface intercepting ditches should be constructed for the protection of cuts.

(3) Intercepting ditches or pipe drains should be provided for the protection of banks built on saturated soils.

(4) Side ditches should be constructed in cuts through all classes of materials.

(5) Pipe drains should be provided for the drainage of wet cuts.

The report is signed by Geo. H. Bremner, (C., B. & Q.), Chairman; S. B. Fisher, (M., K. & T., Vice-Chairman; John C. Beye, (C., R. I. & P.); D. J. Brumley, (I. C.); Moses Burpee, (B. & A.); W. C. Curd, (Mo. P.); W. M. Dawley, (Erie); Paul Didier, (B. & O.); C. Dougherty, (Cons. Engr.); A. M. Kinsman, (B. & O.); Duncan MacPherson, (N. T. R.); W. D. Pence, (Univ. of Wis.); H. J. Slifer, (Pan. R. R.); J. A. Spielmann, (B. & O.); J. G. Sullivan, (C. P. R.); J. E. Willoughby, (L. & N.); R. C. Young, (L. S. & I.).

Discussion.

J. P. Snow (B. & M.): In connection with waterways, is there a formula given to determine the size of waterway? I assume that is not eliminated by the insertion of these conclusions in this report.

Mr. Bremner: It was not the intention of the committee to burden the book of Recommended Practice with any long list of formulae and rules for determining the size of waterways. We expected that would be published in the proceedings, and be available of access to anybody who wished to study the subject. The sub-committee under Prof. Pence has given us some very valuable formulae and conclusions on this subject, and if I understand the gentleman's question, we have not thought of putting it in the book of Recommended Practice.

C. S. Churchill (N. & W.): In connection with paragraphs c and d, I wish to recommend that this committee shall continue further investigation of a comparison of formulae with the idea of putting them alongside each other in such way as to show wherein they harmonize and wherein they do not. The formulae are published now by the committee in such a way that it is not easy to make such a comparison, and I think that there will be found, through the information that will be furnished to the committee by the sub-committee, a means of making such a comparison and bringing out the conclusions next year.

Hunter McDonald (N. C. & St. L.): I do not find that the committee has taken notice of the Chamier formula, which was promulgated about five years ago in a paper before the Institute of Engineers in London, and extracted in the Engineering News shortly after. It takes into consideration the shape of the drainage way and I think should be given consideration by the committee.

Mr. Bremner: The committee asked for information from the association in regard to formulae, and it would have been very glad to consider this formula if it had been presented, and we would be very glad to consider it in the future.

Mr. Bremner: Does that suggestion imply that we should recommend some formula to this association? We have considered that subject very fully and we recommend that no one formula be considered as the standard formula.

Mr. Churchill: I believe we are not prepared at present to recommend any one formula, but the first step is the adoption of such necessary standard formulae as may be desirable to make a comparison of them in considering the different characteristics of this country. I am certain there is one formula presented by the committee that would apply to the middle section of this country, the foothills and mountains of the Appalachian system running up into New England. I am certain that another formula may apply to the middle west section. If we arrange them for comparison, and consider the section of the country for which the formula was originally prepared, we will get valuable information that will be useful to every railway in the United States.

J. B. Jenkins (B. & O.): I suggest that the words "if present" in paragraph 4 under Slides are unnecessary to the sense.

Mr. Bremner: The committee will take that into consideration.

C. H. Miller (Mo. Pa.): Under paragraph 6, I suggest that we make it read "is nearly always most economical." I believe that statement "most economical" is a little too broad.

J. A. Atwood (P. & L. E.): In these conclusions I suppose it is the object of the committee to call attention to the fundamental principles in treating slides. It seems to me they have failed to call attention to one principle, which it is very desirable to bear in mind. Where an embankment supporting a track is sliding, and the cause of it is a washing away, it is very necessary to prevent the toe of the slide from being interfered with, because if the toe is removed the equilibrium of the slide is injured, and sliding results. I think that fundamental principle should be stated by the committee.

Mr. Bremner: The committee considers that that is covered in paragraph 3, taken in connection with paragraphs 1 and 2.

A. W. Thompson (B. & O.): I do not think that paragraph 3 covers the point brought up. I think Mr. Atwood refers particularly to places along rivers where the bank is of such

a nature that in washing away it leaves a slope less than one which that material will stand on.

Mr. Bremner: Perhaps that would come under Washouts.

F. N. Patterson (C., B. & Q.): It seems to me it is fully covered by paragraph 3. In these cases what is wanted is a retaining wall to prevent the toe of the slope from being washed away.

J. B. Berry (C., R. I. & P.): If I may go back to section b under Waterways, I would like to insert the words "bridges and" before "culvert areas." With most roads, the line is drawn at about 25 feet, as between a culvert and a bridge.

Mr. Bremner: The committee will accept that.

Mr. Churchill: Following the suggestion of Mr. Atwood and Mr. Thompson, I find that their point might be covered by adding to paragraph 3 these words: "the object being to restore the equilibrium." That would follow after the words "special cases."

Mr. Atwood: I was just drawing a recommendation to offer as an added section under Slides. The gist of it is something like this: "Where embankments are caused to slide on account of their equilibrium being disturbed by the removal of the toe of the embankment, steps should be taken to prevent the removal of the toe of the slope."

The President: That is covered by Mr. Churchill's suggestion?

Mr. Atwood: I do not think it is; his suggestion is under the head of "piles or retaining walls" which are not sufficient for the purpose I have in mind. I intended to recommend that proper steps shall be taken for the restoration of the equilibrium of the embankment and the prevention of the equilibrium being disturbed.

Mr. Churchill: I think Mr. Atwood's clause covers the matter better than my wording.

Mr. Bremner: The committee seems to think that will merely confuse our conclusions. It seems to be covered in paragraph 2 where we say: "the removal or prevention of the cause is as important as the restoration of the roadway." These two taken together pretty well cover the point.

Mr. Atwood framed his suggestion in writing and later presented it in the form of a motion.

S. E. Coombs (N. Y. C.): Is paragraph 3, under Surface and Sub-Surface Drainage and Tiling of Wet Cuts, intended to apply to bogs?

Mr. Bremner: It can apply to bogs.

Mr. Coombs: Do you think that it would work?

Mr. Bremner: It would depend altogether on the nature of the bog. I hardly think that in most bogs it would work very well.

J. G. Sullivan (Can. P.): In several cases where the embankment is from 3 to 4 feet high, we have had trouble with the tracks sinking in the muskeg. We have been able to eliminate that by grading bogs to a depth of 3 or 4 feet below the general surface of the water.

Mr. McDonald: I find no reference to the method of curing slides by filling the ditches with wood and burning it.

Mr. Bremner: I do not think that method has been brought to the attention of the committee. Mr. Fisher says it is found in some of the letters which have been published in the back part of the appendix.

The President: There is a reference to such conditions in the first volume of the Proceedings, a discussion by H. G. Kelley.

E. F. Wendt (P. & L. E.): I suggest that a plan should be prepared for the Manual to accompany these recommended principles of practice. The Manual already contains diagrams of roadbed for various classes of track, but it seems to me that a plan should accompany the principles in this case as an illustration.

M. L. Byers (Mo. Pac.): I would like to go back to paragraph 2 under Slides for a moment. There is one point which, although it is covered indirectly in almost every recommendation of the committee, it seems to me should be emphasized somewhat. The cause of slides is almost invariably the presence of water, and that is a thing which is frequently not properly recognized. I have had my attention called a good many times to slides that have been making trouble, and the statement has been made that for years they have been trying to correct the slide. When I have asked what has been done, I found that the looking for the cause of the trouble is about the last thing that was done—they had added ballast and additional material, but had not taken the necessary steps to find the location of water and get rid of it. I suggest the addition of this to the first sentence: "and will be usually found in the presence of water." The sentence will then read: "the cause of the slide should be sought and will be usually found in the presence of water."

Mr. Bremner: The greater portion of the committee's report this year is devoted to the considering of water in one form or another—in slides, waterways, washouts and tiling—and we have emphasized the water part of the matter pretty strongly. The first conclusion under "surface and sub-surface drainage and tiling of wet cuts" says: "All the water possible should be kept off the roadbed." As far as slides are concerned, while not always the case, 99 per cent of the cause of slides will be found in the existence of water. It is so self-evident that it is hardly necessary to give it a separate conclusion.

Mr. Coburn (Vand.): If that is the case paragraph 6 is put a little strongly. I have had some trouble during the past year where the cheapest thing was not the flattening of the slope, but taking care of the water.

W. P. Steffens (C. C. & O.): Mr. Byers mentioned the presence of water as always causing the difficulty. There is one other condition that has not been stated and possibly not called attention to heretofore, and that is the presence of mica in large quantities in soil. The mica acts as a lubricator. The natural slope of such material is not 1½ to 1, but possibly as flat as 3 to 1. Our company has been constructing a line south of the Blue Ridge mountains in North Carolina and has been experiencing unusual difficulties in holding embankments due to the presence of this mica material. The embankments in question are naturally made from the material obtained from the adjacent cuts. In many cases the material is of rock, but in other cases it is of this mica clay or earth. The presence of rock on top of the softer material forces out the toe of the slope to an angle at least as flat as between 2½ or 3 to 1.

M. J. Henoch (L. & N.): I would go back to paragraph 6, under Slides. It seems to me it is a very broad statement to say that flattening of the slope is the most economical method of curing a sliding embankment. It seems to me it may in certain cases be very uneconomical and anything but permanent. Therefore, I move that paragraph 6 be amended to read: "The flattening of the slope is recommended as a permanent method of curing a sliding embankment, in cases where natural conditions permit."

Mr. Steffens: In relation to paragraph 6, we have met during the last two years material that will have to be flattened to a slope of 2 deg., if it is to stand. They call it in the vicinity loblolly mud, a sort of clay.

W. L. Webb (Con. Eng.): In illustration of the case mentioned by the gentleman to the left, I will say that the road I was constructing in West Virginia had exactly that same condition of a thin layer of micacious material, and a shallow cut had been made through it. That embankment was on a very flat slope, and yet in the course of two or three days after the side of the cut had been carefully finished off, the whole slope of the hill had been started so that it projected 1½ in. just in a day or two, and it was a case where an extreme flattening of the slope was the only thing that could possibly prevent it.

Mr. Atwood: I wish to offer an additional paragraph to the matter under Slides, as follows:

"Where embankments are caused to slide on account of the equilibrium being disturbed by the removal of the toe of the embankment, proper action should be taken to prevent such removal and to restore the equilibrium."

Any amount of money that you may spend to stop the slide will not stop it if you do not stop the removal of the material which is at the toe of the slope. It is particularly to call attention to the necessity of preventing removal of material at the toe of the slope that I wish to make this addition. In the case of an embankment which is washed by a stream it is particularly applicable.

The President: Does the committee consider that this is covered in any of the clauses?

Mr. Bremner: Paragraph 2 provides that the cause of the slide should be sought, whether caused by washout along the side of the foot of the embankment, by the chemical constituents of the soil, or by water in the embankment. Then the removal or prevention of the cause is as important as the restoration of the roadway. The committee would consider that this clause covers not only the case which is provided for in this motion, but also a number of other cases.

Mr. Byers: It seems to me that the argument of the chairman could be applied with equal force to almost all the paragraphs that follow No. 2. The object of Mr. Atwood's motion is to call attention to a special case, just as several of the other paragraphs call attention to special cases.

Mr. Ewing: I think the committee's recommendation should stand and not go into too much detail. Another point I have in mind is that it is necessary to put a ditch on top of the

cut as it is to protect the bottom, to prevent the slides from washing.

Mr. Churchill: The one point that has, in my estimation, been omitted by the committee is that of restoring equilibrium. Of course all railway people understand that in a general way, but still it is not stated in the conclusions, and that is why, primarily, I favor the addition of the clause. There was brought to my attention a few days ago a statement from one of the oldest railroad men in the United States, in connection with the oldest portion of our road, built in 1850, and this old gentleman stated we had great difficulty at that point. Our construction began to slide out,, and we immediately began to determine how we should prevent it. We made an investigation and found that the only way to prevent it was to restore the equilibrium, which we did by using a very heavy granite rock around the toe. If you cannot restore equilibrium, you must carry out the measures the committee have recommended. If you can restore the equilibrium, it is right to do so. I think the word "equilibrium" is an important word to consider.

The President: The question is upon the motion of Mr. Atwood to supplement the conclusions with another paragraph, to be known as No. 9, which you have heard read.

The motion was lost.

Mr. Thompson: It seems to me that the committee have considered here that every slide should be corrected. There are some cases where it is not economy to remove the cause of the slide. The interest on the cost of permanently removing the cause of the slide is greater than the annual maintenance charges of keeping embankment.

Mr. Bremner: The committee would not consider that any one of these recommendations are absolute. There are bound to be exceptions to every one.

Mr. Churchill: You might stop there, leaving the whole thing alone.

Mr. Bremner: We wanted to emphasize that particular form of slide. Every regulation we might make would be subject to exception.

L. S. Rose (Big Four): I move the adoption of all the conclusions.

Mr. Coburn: I move as an amendment that sections 6 and 7 be changed by substituting the word "frequently" instead of "nearly all." I think it would make a vital change in the recommendations.

Mr. Bremner: I think the words "nearly all" give a better meaning.

The motion was defeated.

Mr. Wendt: In former years the committee submitted the definition for the term "waterways," which now appears in the Manual. I suggest that next year they submit definitions for the two terms "slides" and "washouts," in order that the Manual may be complete.

The President: The committee will take notice of that. It has been moved and seconded that the conclusions as amended be adopted.

Motion carried.

BUILDINGS.

The Board of Direction assigned the following topics for consideration:

(1) Reconsider amended conclusion No. 5 (1908) relative to locomotive coaling stations.

(2) Report on the use of reinforced concrete for coaling stations and storage bins.

(3) Collect data as to the actual use of reinforced concrete roofs for roundhouses, where located, life to date, results so far obtained, and critical analysis of advantages or possible defects; also diagrams of typical designs.

(4) Report on the best method for smoke removal, ventilation and heating of roundhouses.

(5) Report on the design and detail arrangement of oil houses at terminals.

The committee considered it unwise at the present time to reopen the question in Topic 1. The developments of the next few years may make it desirable to take the matter up at some future time.

The sub-committees and division of the work was as follows:

(A) Topic 4; (B) Topics 2 and 5; (C) Topic 3.

Reinforced Concrete for Coaling Stations and Storage Bins.

An exhaustive search was made of the coaling stations and storage bins already erected, but comparatively few plants of this character are in use. Railroad engineers who have constructed such plants generally regard this type as satisfactory, but are not yet prepared to recommend its general use, because of the increased cost.

Figures from the builders of reinforced concrete coaling stations indicate that they cost 50 per cent. more than timber.

Reinforced Concrete Roofs for Roundhouses.

In referring to "reinforced concrete roof" we mean one which is also supported by reinforced concrete beams and which fully conforms to the definition of reinforced concrete.

A reinforced concrete roof, properly constructed, is not porous enough to allow leaks or to permit gases and moisture to corrode the reinforcement except as it may crack. The cracks can be kept at a minimum, and, it is believed by some engineers, so prevented that the roof shall stay waterproof without any covering by reinforcing it against all the tension stresses due to expansion and contraction. During the past two years some large buildings have been erected on this theory, and so far they are giving excellent results, but the committee feels that until these buildings have had a longer test it should retain the position it held last year. It cannot recommend a concrete roof for a roundhouse without a roof covering on top of the concrete, although in a roundhouse where a leak cannot do serious damage, more risks can be run than with some other buildings.

We are also not sure that we were justified in recommending a cheaper roofing for the concrete, as was done last year, and have revised our table of costs, given in that report, in that respect.

The committee is of the opinion that, unless the roof leaks badly, any pores in the concrete will be closed up by the cementwash or whitewash put on after the house is completed, or else by soot, and that the chance of any damage from corrosive gases is practically nothing. Some elaborate experiments made in Germany in 1907, by E. Probst, had this subject under consideration. These tests subjected concrete beams under load to a highly concentrated mixture of steam, oxygen and carbon dioxide, which entirely corroded unprotected bars in 24 hours. Some of the beams were loaded up to nearly the elastic limit of the steel, and no rust resulted after the beams had been subjected to the gases for over 12 days. However, when the beams were so loaded as to exceed the elastic limit of the steel, cracks were found which caused considerable corrosion. In a building properly constructed such cracks could not occur. The atmosphere in a modern roundhouse is such that a long time must elapse before enough corrosion can occur to equal the severity of the action of a few hours under the tests quoted.

As to excessive condensation on the underside of the roof during cold weather, this does not take place with a concrete roof when the house is properly heated, and in any event there is no more condensation than with a wooden roof.

But few roundhouse roofs have been built exclusively of reinforced concrete, none of which has been in use much over two years. As far as we can learn, the results have so far been entirely satisfactory. Those of which we know are as follows:

Grand Trunk	Mimico, near Toronto, Can.
Detroit & Toledo Shore Line	Toledo, O.
Denver & Rio Grande	Pueblo, Colo.
Denver & Rio Grande	Burnham, Colo., near Denver.
A., T. & S. F. Ry. Coast Lines	Bakersfield, Cal.
A., T. & S. F. Ry. Coast Lines	San Bernardino, Cal.
A., T. & S. F. Ry. Coast Lines	Richmond, Cal.
A., T. & S. F. Ry. Coast Lines	Williams, Ariz.
Union Railroad	Oak Hill, Pa., near Pittsburgh.

The recommendations included in this report concerning ventilation can be carried out with reinforced concrete.

In revising the table of comparative costs the committee has been conservative by endeavoring to avoid any chance of favoring the concrete roof in the costs of labor and material and in all items where there is any doubt.

In figuring insurance on the structure, we have included that to be carried on the entire building and its equipment, and not alone on those parts of construction included in the table.

There has been ample demonstration of the fireproof qualities of reinforced concrete. It is well adapted for a roundhouse, and the demands upon it there are not essentially different from those it receives in other buildings. We would, therefore, recommend the following to replace conclusion (2):

"Under ordinary conditions the reinforced concrete roof is the most desirable for a roundhouse, because of the greater security afforded by it against interruption to traffic through damage to the roundhouse and its contents and because of its economy."

We would recommend the revision of conclusion (3) to read as follows:

"When the roof is of reinforced concrete the columns and roof beams should be of the same material."

We would recommend the revision of conclusion (4) by the addition of the word "considerably" after the word "cost" in the second line, making it read as follows:

"Reinforced concrete should be used for the walls only where special conditions reduce its cost considerably below that of brick or plain concrete and where plaster is not considered satisfactory."

Smoke Removal, Ventilation and Heating of Roundhouses.

The following questions were submitted to a large number of roads:

(1) What system of heating do you employ in your standard engine houses?
  (a) How long has it been in use?
  (b) Are results satisfactory?
(2) What cross-section engine house do you use?
  (a) Has your experience with this section shown any modifications of it advisable?
(3) Do you employ auxiliary mechanical ventilating appliances or have you ever considered the advisability of doing so?
(4) What type of smokejack do you use?
  (a) What are the general dimensions and of what material is it composed?

Replies were received from 32 roads, the answers being carefully studied and tabulated. From them the committee presents the following arguments leading to conclusions which are borne out by experience and usage of the roads replying to the inquiries:

HEATING.

The primary consideration being to thaw out engines, the heat should be concentrated at the pits. There is no need to have the house very warm as the men are warmly dressed and will work faster if not too warm.

Good results are obtained by the use of steam heat coils in the pits. Positive circulation is required, the vacuum return system seeming to be the best. Where steam coils are used, care must be taken to prevent water from splashing on the pipes, which forms a fog in the house, and also tends to crack the pipes, causing leaks; also special care must be taken to insure sufficient ventilation on account of the lack of a positive air change. While steam heat is cheaper than hot-air, the maintenance cost is larger.

Your committee recommends the adoption of the following conclusions as a substitute for recommendation No. 11, page 68, in the Manual:

Conclusions.

(1) Heat should be concentrated at pits.

(2) General temperature of the engine house should be kept between 50 and 60 deg.

(3) The best method for heating engine houses is by hot air driven by fans through permanent ducts (under the floor where practicable). The supply should be taken from the exterior of the building (no recirculation should be allowed). The air should be delivered to the pits under the engine portion of the locomotive. Air to be heated as far as may be by exhaust steam, supplemented as required by live steam.

VENTILATION.

A continuous upward movement must be secured, best accomplished by designing the roof so that "slope-up" is given to a continuous opening around the house and by the use of annular openings around the jacks. The purlins and rafters must be arranged so that they will guide the air currents up to the openings instead of obstructing them. The replacement by fresh air is most surely accomplished by hot-air heating. Where no heating is needed, openings can be provided of such size that no mechanical ventilation will be required.

SMOKE REMOVAL.

Ventilation and smoke removal are dependent upon a correct design of the house and of the jacks. Smoke removal can be accomplished by efficient jacks of smooth material and of adequate size and length.

Conclusions.

Smoke removal should be separately provided for by the use of jacks, and the currents produced in the jacks should be utilized for aiding ventilation in the house by drawing air from the top of the house through annular openings leading into the top of the jack. Jacks should be without dampers, fixed, and built of non-corrosive material with cross-section not less than 30 in. in diameter. They should be of smooth material, circular in section above the hood, and extending well above the roof line; care in design should be taken to avoid any corners. The hood of a jack should have a minimum length of 10 ft. so as to permit variation of location of an engine on the pit. The bottom of the jack should be as low as the engines served will allow and it should be furnished with a drip trough; the slope upward should be gradual to the flue.

We recommend that our conclusion in regard to jacks be substituted for recommendation No. 8, page 68, in the Manual, and that the paragraph on Smoke Jacks, page 70, of the Manual, be stricken out.

Design and Detail Arrangement of Oil Houses at Terminals.

When conditions permit an oil house should be located a sufficient distance from other buildings to prevent the spread of fire. This, however, is not always practicable and, in fact, it is usually convenient, or necessary, to have the oil storage adjacent to the storehouse or some other building.

The danger from fire, which existed under the old methods of distributing oil for use directly from the barrels, has been greatly reduced by modern methods of storing the oil in tanks usually under ground, or in a basement, and this improved method also results in an important saving by elimination of waste of the oil.

Quantities of oil, either at large terminals or at isolated points, should be kept in tanks located either underground or in buildings properly designed for the purpose.

At isolated points it is usually feasible to have the oil storage tank underground at a considerable distance from combustible buildings, but at terminal points it is usually necessary or convenient to have the tanks close to the point where the oil is to be drawn for use. In either case the piping can be arranged to draw the oil by hand pump, with proper arrangements for taking care of the dripping, or by the more modern systems which, if desired, can be arranged to measure accurately the quantity drawn, practically eliminate dripping, permit of locking and which are susceptible of other modifications and additions if desired.

A cross-section of a typical oil house 20x40 ft., is submitted. The construction features are adapted principally from two or three of the designs which were among the best received.

On the main floor should be the pumps or faucets by which the oil is drawn for use. This floor would also be used for unloading barrels of oil for filling the tanks by means of pipe connections through the floor, for storage of waste in metal receptacles and for such other purposes as would be convenient and proper. Oil which comes in tank cars would be piped direct to the tanks in the basement; or these tanks could be located underground outside of the building and the basement used for other purposes, but the storage tanks should be in a place where they are easily accessible.

Compressed air has been used instead of hand pumps for delivering the oil, but as the mixture of air with the oil interferes with the delivery at the faucet, besides causing deterioration in the oil itself, it has not been an entire success. The use of compressed air for this purpose is not necessary, as the modern systems on the market deliver the oil satisfactorily and measure it accurately, even when the point of delivery is at a considerable height above the storage tanks.

Conclusions.

(1) When practicable, oil houses should be isolated from the other buildings at a terminal.

(2) Oil houses should be fireproof and the storage should be either underground or in the basement.

(3) Oils that are stored in sufficient quantities should be delivered to the tanks in the house direct from tank cars. For oils that are stored only in small quantities provision should be made for delivery to storage tanks from barrels by pipes through the floor.

(4) The delivery system from the storage tanks to the faucets should be such that the oil can be delivered quickly and measured. The delivery should also be such that there will be a minimum of dripping at the faucet and that the drippings be drained back to the storage tanks.

The report is signed by O. P. Chamberlain, (C. & I. W.), Chairman; Maurice Coburn, (Vand.), Vice-Chairman; Geo. W. Andrews, (B. & O.); S. D. Brady, (L. K.); A. C. Butterworth, (Mo. P.); H. M. Cryder; Wm. T. Dorrance, (N. Y. C.); C. H. Fake, (M. R. & B. T.); P. F. Gentine, (Mo. P.); E. N. Layfield, (C. T. T.); M. A. Long, (B. & O.); John S. Metcalf; W. H. Sellew, (M. C.); L. D. Smith, (S. P.); C. H. Stengel, (Vir.); E. W. Wiggin, (N. Y., N. H. & H.).

Discussion.

The clause recommended by the committee to replace conclusion 2 in the Manual, beginning "Under ordinary conditions the reinforced concrete roof is the most desirable for a roundhouse, etc.," was considered first.

C. F. Loweth (C., M. & St. P.): I am quite in accord with the committee to the extent of saying that a concrete roof for a roundhouse may be very desirable and that frequently it

will be economical compared with the ordinary timber construction that might be used, but I think it is going too far to say that under ordinary conditions all roundhouses should be built with reinforced concrete roof. I think the position that the convention took last year is going far enough, and I see nothing to be gained by going any farther. Last year we said that the security by having reinforced concrete roof warranted its consideration. I move that the conclusion of the committee be not concurred in.

W. B. Storey, Jr. (Santa Fe): The Santa Fe has probably a larger number of reinforced concrete roundhouse roofs than any other company in the association. As representing that company I wish to second Mr. Loweth's motion. I agree with the reasons advanced by him and believe that we should abide by the action taken last year and not adopt the present conclusion.

Mr. Coburn: The committee went over the Proceedings of last year pretty thoroughly before making the recommendations and endeavored to learn all we could about the subject. We were asked to present what additional information we could as to the houses already built and results obtained from them. From the information we could gather the results have uniformly been successful as to every point. We went into the question of the chance of corrosion of the steel in the concrete, and we found that the elaborate experiments made in Germany on this subject seemed very conclusive. The large number of reinforced concrete chimneys which were being built would seem to warrant the faith in reinforced concrete in places where corrosive gases are liable to be present. In chimneys conditions are so much worse than in a roundhouse, it seemed to us that the chance for corrosion in a roundhouse is nothing at all.

It seemed to us that the advantages to be gained by the construction of a concrete roundhouse are so great and the results so far obtained in this work, and the many uses to which it is being put, warrant us in adopting the conclusion which is recommended. Concrete buildings are being built all over the country, in places where they are subjected to much severer conditions than we have in a roundhouse, and we think it is no experiment; and above all is the avoidance of danger from fire and other external causes. The roundhouse fires are a good deal more numerous than one thinks until he goes into the subject and they are such a serious item when they do occur that anything we can do to avoid them is well worth while. A house with a concrete roof, in the long run, is going to take considerably less for repairs and be more economical.

L. C. Fritch (I. C.): It seems to me that the recommendation now in the Manual is much more to the point and covers exactly the ground Mr. Coburn has touched, the matter of fire protection. Personally, I would like to see Mr. Loweth's amendment carried.

J. O. Osgood (C. of N. J.): I agree with Mr. Loweth and the others that it is not wise to pass the recommendation as stated by the committee. Our company has a number of concrete roofs. We have used them in quite a number of places, and we have looked towards using them in roundhouses, but we have not yet been able to figure out that there was any real economy in doing so. There may be, under certain conditions, but the difficulties of protecting the steel, and at the same time keeping the cost of the roof within reasonable limits we find a difficult matter, and up to this time have not been able to use it. It seems to me it would be unwise to have any statement appear in the recommendations indicating that the roof is an economical one. We have not been able to figure out that it is economical.

C. H. Cartlidge (C. B. & Q.): I think we should either endorse using reinforced concrete or refuse to endorse it; say what we definitely recommend in the style of construction. I think most of us will agree that a reinforced concrete roof is desirable under a great many circumstances, but I think we ought not to agree to exclude every other sort of roof.

The President: The question is on Mr. Loweth's motion, that clause No. 2, as suggested by the committee, be not concurred in.

Motion carried.

The recommended revision of conclusion 3 was next considered.

Mr. Cartlidge: I move that the conclusion of the committee as presented be not concurred in.

Mr. Osgood: I object to that. I do not believe in undertaking to prescribe reinforced concrete columns. I think the objection to them is greater than to reinforced concrete beams. Reinforced concrete columns may occupy more space than cast iron or wrought iron columns, and the columns are not likely to suffer to any such extent as the roof from the action of the gases.

Mr. Cartlidge's motion was then carried.

The recommended revision of conclusion 4 was taken up.

Mr. Loweth: I would like to ask the committee, what is the reason for this change? It would appear on the face of it that they have experienced a change of heart since last year as to relative advantages of a reinforced concrete wall or plain brick wall.

Mr. Coburn: We have not really changed our mind, except that we think a brick wall is more satisfactory than a reinforced concrete wall, and unless you are going to save money by it, we do not recommend a reinforced concrete wall.

Prof. Allen: Would not the proper reading be "the cost" instead of "its cost"?

The President: Yes, the committee will accept that suggestion.

Upon vote the recommendation of the committee was adopted.

M. L. Byers (Mo. P.): I suggest that we adhere to the use of the word "enginehouse" instead of "roundhouse" throughout.

The President: The committee will take it under consideration.

The conclusion on smoke removal was next considered.

Mr. Chamberlain: The principal reason for the recommended changes is that there is already a conflict in the Manual, and going over this matter after the conclusions had been adopted by the committee and checking it up with the Manual, it seemed wise to try to get the matter in the Manual in such shape that that conflict would not exist.

Mr. Cartlidge: I move to amend the conclusion of the committee by the inclusion of the word "preferably" between the words "and" and "built" in the fifth line, so that it will read: "Jacks should be without dampers, fixed and preferably built of non-corrosive material."

The President: The committee will accept such an amendment.

Mr. Loweth: I would like to inquire what is meant by "non-corrosive" jacks. A large percentage of the roads throughout the country are using cast iron jacks. Cast iron is corrosive.

Mr. Osgood: That may refer to some of the asbestos materials. Recently we have had some experience with that class of material which indicates that if it is non-corrosive it is not lasting. Some that we put in a few years ago has already begun to fail. It failed as quickly as cast iron.

Mr. Coburn: The committee, by the use of the word "non-corrosive," meant a material that was not affected by gases escaping from the stack of the locomotive, so that the jacks would be practically permanent, at any rate as permanent as the enginehouse. The committee had no particular material in mind and simply intended to indicate that a permanent jack should be used.

G. H. Bremner (C., B. & Q.): I would like to ask if it is not a fact that most of the jacks at the present time are not being made square or rectangular?

Mr. Coburn: The committee believes that the function of the jack is to ventilate the house and that the circulation of air is better secured by circular opening, rather than by a square opening. The currents of air are freer to move and there is no retarding effect by currents in the corners, and a circular shape is, therefore, the ideal shape.

Mr. Loweth: I believe I am right in saying that there are a good many roads in the position of the road I represent that are getting good results from the type of smoke jack that differs in material from this recommended here, and I fail to see why we should put ourselves on record as being so definite about a detail which may have some advantages in it which are worth considering, but have no advantages over a good many other devices that are equally efficient and may cost less money. So I, therefore, move that this conclusion be not concurred in.

Mr. Chamberlain: I think the matter has not been brought as clearly before the convention as it might have been on account of not having read the conclusions for which we present this substitute. Outside of the fact that there are some changes in the recommendation, there also remains the condition that exists in the present Manual in which there are some inconsistencies; that is, there are two different things recommended, two pages apart, and that was one of the things which we wanted to get rid of; and while I concur in the recommendations of this committee, there is very little in the recommendations which differs from what is already in the Manual.

Mr. Fritch: I hope that Mr. Loweth's amendment will carry and that the present recommended practice stand. The committee, in its new conclusions, have left out a very essential element, and that is that the material from which the

jack should be built should be non-combustible. I think we should get away from the practice of wooden smoke jacks. It is one of the greatest sources of danger from fire that we have. I hope the old conclusions will stand.

Mr. Chamberlain: In regard to that portion of the conclusion, the committee would be very glad to accept, in the fifth line of the conclusion, a substitution to read: "Fixed, and built of non-combustible, and preferably non-corrosive, material." As the recommendations are in the Manual there is a clash. One recommendation calls for a 42-in. flue and the other for a 30. Those two recommendations should be harmonized in some way, and one of the objects of this change in the conclusion was to get rid of the discrepancies which are now in the Manual. I hope that Mr. Loweth's motion will not prevail.

The President: The chair will ask Mr. Loweth if the suggestion made by the chairman of the committee will meet his views?

Mr. Loweth: No, sir, it will not. We have a great many jacks that will not line up with this conclusion. I think the road jacks would not. I venture to say there are very many jacks in satisfactory use throughout the United States that would not conform to this conclusion.

Mr. Fritch: I would like to offer an amendment to Mr. Loweth's motion, to strike out from the Manual recommendation No. 8, page 68.

Mr. Loweth: I will accept that.

The President: The question is to strike out from the Manual conclusion No. 8. Are you ready for the question?

The question was then carried.

Mr. Chamberlain: I still think the conclusion on page 70, on smoke jacks, should be substituted for the recommendation which has been stricken out. That is to put the matter in an orderly manner in the Manual. I will make that as a motion.

Mr. Wendt: We intend to do that.

The President: The Board will see that the suggestion is carried out.

The conclusions on heating were next considered.

Mr. Loweth: Speaking with reference to conclusion No. 3, I would move to strike out the two clauses enclosed in brackets. The first is too sweeping as stated. It is always practicable to put the duct under the floor, but it may be exceedingly expensive, and in old roundhouses and in a new roundhouse it is cheaper, and in many cases at present we put the air duct up in the roof. With reference to the second bracketed paragraph, there are hours in the day when it is quite proper to allow a recirculation of the heated air. There are frequently times when the exhaust steam is not sufficient to furnish all the heat that is necessary and I think the parties in charge of the roundhouse should be privileged to exercise their judgment whether a recirculation of air is right or not.

Mr. Chamberlain: The recommendation is not different from the recommendation already in the Manual, that portion of it. I move the adoption of the conclusions as stated in the report.

The motion was carried.

The conclusions on oil houses were next considered.

Mr. Fritch: The typical oil house plan does not show any provision for ventilation. There is also no provision for taking care of waste.

Mr. Layfield: The intention was that this drawing should be corrected, and an opening left in the top of the wall just below the floor, to be properly screened so as to prevent access from outside, but to permit ventilation. Also there is no suggestion here as to heating. Of course, that should preferably be done by steam pipes. As to provision for waste. It is common in oil houses of that kind to have the waste kept in metal tanks on casters so that the tanks can be moved around. If the houses were large enough, and the quantity of waste greater, it could be kept in metal receptacles or reinforced receptacles.

Mr. Fritch: I move that this conclusion be received as information and the matter referred back to the committee for further report.

Mr. Chamberlain: I doubt very much the advisability of referring these conclusions back to the committee. I think the members of the convention will agree with most of these conclusions presented. Whether the committee has gone far enough, or whether the committee has omitted something which should have been considered, is another question. I would very much prefer that if the conclusions as presented meet with the approval of the association, even though the matter be referred back, that this portion of the conclusions be adopted and placed in the Manual.

The oil house plan does not go into the Manual. We have not recommended that the plan should go into the Manual. It is simply what we regard as typical, as Mr. Layfield told you, made up by careful investigation of many plans which we received from the roads. The matter of ventilation has not been gone into in that particular plan, but do not consider this a typical design so far as the building goes. We say in the report: "Modifications of this design can be made to apply to other sizes and arrangements of oil houses." Our object is to show what we consider the proper way of handling the oil portion of it. It would be almost unnecessary to state that the oil house should be ventilated, just so it should be unnecessary to state that any other building should be ventilated.

Mr. Wendt: I seconded the motion to refer the matter back to the committee, not because I do not agree with the conclusions, they are correct, I think, very largely as stated. It does seem to me, however, that the association is reaching a point where it would be necessary to guard the Manual of Recommended Practice by a rule which will require that we make no final conclusion until it has received a second presentation, and been read a second time, at a second convention of this association. Any careful and critical study of the Manual will lead to the conclusion that we are too hasty in adopting what is to go out to the world as permanent fixed recommended practice.

My thought was strongly in accordance with the statements of Mr. Chamberlain, that it probably was advisable to supplement and enlarge the report and make a recommendation which will be more extended and more comprehensive. That is my only reason for seconding the motion.

I hope that we will not take this matter under consideration too hastily, printing conclusions which may in a sense be incomplete, because our proceedings are now in use in Australia, New Zealand, India, China, Japan, and in every advanced country of the entire world.

Mr. Chamberlain: I think what Mr. Wendt has said in regard to the precaution which should be taken concerning the printing of material in the Manual has some merit. At the same time we are working under the present rules of the association. Under these rules, this matter if it meets with the approval of the association should go into the Manual. If further supplemental material is needed, refer the matter back to the committee and have it investigated further; but do not, just because this report possibly is not as complete as you would wish, turn it all back to the committee, if you approve of the recommendation. The committee can substitute something else, or make additions another year.

The point I desire to make is that if these recommendations conform with your opinion on the matter, they should go into the Manual under the present rules. If the present rules are changed later on, and these matters have to come up twice before the association, then we will work under those rules; but now we are working under another system.

Fred Lavis (P. T. & T.): The point was raised a short time ago by the chairman of this committee that certain matter was already in the Manual, and the change which was proposed in that connection was simply continuing what had already been approved in the Manual. It would seem to indicate that if the matter were once in the Manual a precedent was established. I, therefore, agree we should be careful indeed as to what is put in the Manual if that is to be the position that is taken.

Hunter McDonald (N. C. & St. L.): I make a point of order that Mr. Wendt's remarks in regard to the reconsideration of each clause at two meetings are not in order. The question now is on the adoption of the committee's report, which is submitted under the present rules of the Manual. I wish to call his attention to Clause 6 of the Rules for publication of the Manual, which reads as follows:

"The Board of Direction shall have authority to exclude from the Manual any matter which, in its judgment, it shall consider as not desirable to publish, or as not being in proper shape, or as not having received proper study and consideration."

Mr. Wendt has been delegated by the Board of Directors to pay especial attention to that particular thing, and it is up to him to keep out of the Manual anything that has not been properly considered.

The President: The point has been well taken.

Mr. Chamberlain: I do not want to take up too much of your time on this. There has been no objection presented by any member of the association to any one of these conclusions. Now, under these circumstances, why should those conclusions be referred back to the committee? I think the conclusions are approved by almost every member on the floor of this convention today.

Mr. Fritch: With the consent of my seconder I will withdraw the motion.

Motion withdrawn.

Mr. Loweth: If I understand the situation, these conclusions stand and an amendment to any one is in order.

The President: Yes.

Mr. Loweth: In that case I offer an amendment to conclusion 2, to make it read as follows: "Oil houses should be fireproof and a storage in large houses should be preferably either underground or in the basement." I propose that amendment because in small houses the expense of putting storage underground or in the basement is out of all proportion to the risk. In many cases it is unnecessary, and it is only in the larger houses that we are warranted in going to the expense of underground storage.

Mr. Chamberlain: The committee will accept that.

Mr. Layfield: As chairman of the sub-committee, I will say that in writing that conclusion I merely had in mind a house such as is shown in the drawing, which, of course, will not go into the Manual. Therefore, I see no objection to the change suggested.

The President: It has been moved and seconded that the committee's conclusions in regard to oil houses be adopted.

The motion was carried.

Mr. Chamberlain: On account of the changes in the proposed conclusion, and the fact that this matter was taken up a little out of the order in which it was presented in the report, I will take a few moments to call your attention again to three topics which have not been discussed. The Board of Direction in its instructions to the committee submitted as the first topic the following:

(1) Reconsider amended conclusion 5, relative to locomotive coaling stations (Bulletin 95, pp. 69-70).

The President: The secretary will read that conclusion, if it is desired.

Mr. Chamberlain: I do not think it is necessary to take the time of the convention in this matter. I will say the committee did not do any work on that recommendation. It will be the proper thing for the convention to refer it back for next year's report. In this connection I will read from our report: "Your committee, while not feeling that the subject had been exhausted at the last convention, considers that it is unwise at the present time to reopen the question. The developments of the next few years may make it desirable to take the matter up at some future time." If it be the will of the convention that we take this matter up next year, we will be glad to do it.

The second topic on which the committee was to report was: "The Use of Reinforced Concrete for Coaling Stations and Storage Bins." I will say that the committee did make quite an investigation of the use of reinforced concrete for coaling stations and storage bins. We found that some few had been built on some of the roads, but we did not make any recommendations in regard to them. Reinforced concrete for coaling stations and storage bins is a comparatively new proposition, and it is the feeling of the committee they are rather an expensive proposition at the present time for most roads. We have talked with some of the engineers of roads on which they have been constructed, and they are inclined to agree with us in this view. However, there are more and more of these buildings being constructed each year and it would be quite proper for that matter to go back to the committee for next year's work.

Mr. Wendt: I suggest that the committee consider the formulation of a few definitions, and that the present conflict in the Manual between the use of the words "roundhouse" and "engine house" be harmonized.

IRON AND STEEL STRUCTURES.

Your committee submits a progress report on impact tests, and a report on the maintenance of bridges, including protection of steel structures from corrosion.

Impact Tests.

The committee submits a simple statement of field work carried on during last summer. Thirteen instruments were available for use and were generally employed. These consisted of 12 extensometers and one deflectometer. The general method of conducting the work was the same as during the previous season, but the range of bridges upon which experiments were made was considerably greater. The committee endeavored to make the series fairly complete for plate girder spans of various lengths and for short riveted spans. Additional data were obtained also on pin-connected spans, the maximum length being 300 ft. Particular attention was also given to tests on bridges with ballasted floors. Twelve bridges of this type were included in the series.

A brief description of the several bridges tested, their location, number of records secured on each bridge and date of observations are given in a table, and information concerning the types and weights of locomotives is given in another table. Including last year's records, the total number of records secured amounts to some 15,000. Obviously the measurement, plotting and analysis of these records will take much time, and it has been impossible to prepare, in time for publication, such a synopsis of the results as would be of any practical value.

Maintenance of Bridges, Including Protection from Corrosion.

PART I.—MAINTENANCE.

(1) Debris, Dirt, Etc.—Debris should not be permitted to accumulate at bridges, and all parts of structures should be kept well drained, and free of dirt, cinders, etc.

(2) Substructures.—(a) When substructures show indications of movement or other weakness, they should be promptly protected by riprapping, piles, bracing or other work, until the permanent repairs are made.

(b) Cracked bridge seats or pedestals should receive necessary repairs or renewals.

(3) End Bearings.—(a) Roller bearings or sliding seats should be kept in good condition so that they may have the proper play or movement.

(b) Bed plates should be kept leveled up to give good bearing.

(c) Wooden wall plates should have sufficient bearing area between the flanges and the wood, to prevent crushing, which is liable to cause bending or splitting of the flanges.

(d) The superstructure should be kept clear of the masonry in order to prevent buckling of the metal work.

(4) Track.—(a) The track construction on bridges and approaches should be well maintained, with good joints, and well bedded or fitted ties in order to insure smooth running.

(b) Ties should be secured against bunching in case of derailment, be spaced sufficiently close to support derailed wheels, and generally should not be more than 6 in. apart in the clear. They should be sufficiently wide so that the intensity of pressure between the rails and the wood under the heaviest locomotives will not cause cutting into the wood. Tie plates should be used when necessary. Ties should be proportioned according to General Specification requirements.

(c) Both inside and outside guards should be used, the inner guard of steel, and the outer of wood, notched over and connected to ties so as to prevent bunching.

(d) Screw-spikes in bored holes, instead of driven spikes, may be used to increase the durability of ties and to insure good track.

(e) Defective or damaged timber should be promptly removed.

(5) Rivets.—(a) Good judgment should be used in dealing with loose rivets. They should be cut out and replaced with tight rivets except in cases of no importance, care being taken not to loosen adjoining rivets nor injure the material. When there are only a few rivets in a connection, it may be necessary to cut out all rivets to secure good work.

(b) In backing out rivets which offer great resistance to removal, a 3-in. round steel bar, with socket in the end of diameter and depth to receive the expelled rivet, is recommended as a good tool to facilitate removal and protect the surrounding work.

(c) After rivets are cut out, the holes should be carefully reamed when necessary to make them true, in which case a larger rivet should be used.

(d) In replacing loose rivets care should be taken to reduce the effective section as little as possible, especially in sections of small size.

(e) When the rivets in the top flanges of track stringers become loose and do not remain tight after re-driving, a reinforcement should be designed and applied under the direction of the engineer. When necessary, the flange angles may be supported by additional stiffeners tightly fitted under the top flanges, so that loads may be transferred more effectively to the web plates.

(f) Where stringer connections to cross floor beams, or cross floor beam connections to trusses or girders, show indications of overload, and the rivets cannot be kept tight, suitably designed reinforcement should be applied under the direction of the engineer.

(g) Where a portable air riveter is available its use is recommended when the number of rivets requiring removal and re-driving will not unduly increase the cost. Difficulty in driving, in cases where space for the swing of a hammer is limited so that good upsets are not obtained, may justify the use of a portable air riveter, even though the number of rivets may not be large.

(6) Bolts.—(a) Bolted connections should be kept tight, and where nuts are liable to get loose, threads should be burred. Where required, check nuts should be used, longer bolts being inserted when necessary to receive the extra nut.

(b) When bolts take shear and have become loose, a reamer should be used to true up holes, and the bolts replaced by others of larger size, making a driving fit. Unturned bolts may be used except in important connections, provided holes are reamed slightly smaller than the bolts.

(c) Reamers and bolts should be standardized and kept on hand, so that securing tight-fitting bolts, whether rough or turned, may be attained without delay and unnecessary expense.

(d) All bolts taking shear should have washers under the nuts. Washers should not be less than ⅜-in. thick, and from 2 to 2¼-in. in diameter, to insure the body of the bolt engaging the entire thickness of the metal connected.

(e) Care should be taken to have threads on bolts taking shear cut to the necessary length only, so that the body of the bolt will be effective, and the threads terminate in the washers.

(7) Adjustable Members.—(a) When counter rods with turnbuckles do not remain in adjustment, they should be treated in accordance with the advice of the engineer, since it may be necessary to replace or reinforce them on account of loads in excess of those for which they were designed.

(b) Adjustable lateral rods should be kept taut so as to keep lines true, and the connections should be maintained in good condition.

(8) Packing Pieces and Clamps.—(a) Loose eyebars should be prevented from rattling and wearing the pins and holes, by the use of packing pieces and clamps.

(b) Abrasion and cutting of rods or other members by rubbing contact caused by vibration should be prevented by the application of packings, clamps or stays.

(9) Pin nuts should be kept tight.

(10) Reinforcement.—(a) Each structure should be studied for the purpose of determining the amount of possible efficient reinforcement, consideration being given to the relative economy of its application and of the renewal of the structure.

(b) Partial renewal or local patching may be advisable, in which case all damaged or corroded parts should be restored as nearly as possible to not less than their original efficiency.

(c) All reinforcement or alterations of any kind should only be made under the direction of the engineer.

PART II.—PROTECTION FROM CORROSION.

(1) Protection Necessary.—A protective coating of paint on the structural steel and iron in bridges should be maintained in order to prevent corrosion which will impair the efficiency and endurance of the structure independently of the wear and strains produced by the traffic.

(2) Quality of Materials.—The constituents of paint should be of the best quality, since the cost of application far exceeds that of the materials and is the same for good and poor paints. The quality of the pigments, oil and dryers should therefore be covered by proper specifications and tests.

(3) Selection of Paints.—(a) The duty required should govern the selection of the materials for paint. Cognizance should be taken of weather conditions, since they differ widely in different localities in respect to humidity, rainfall and temperature. Consideration should be given to localities near and in cities, where the atmosphere contains the gaseous products of combustion, structures being frequently exposed to severe conditions in this respect. Special attention is required in the case of crossings, where overhead bridges are exposed to the gases and cinders expelled from locomotives on the tracks below. Special treatment should be given to coatings required to resist the drippings from refrigerator cars, or when the service is special in any respect.

(b) The selection of paint for any situation should be governed by previous duty performed by the various compounds in similar situations. Records should be kept of the various coatings used, accompanied by all particulars of their application and service necessary to determine properly their efficiency and durability. Such records when correctly kept are the best guide in the selection of materials.

(c) In repainting over old paint, consideration should be given to the character of the old paint, since imperfect adhesion of the new coating may result in injurious effects.

(4) Procuring Paints.—(a) Paints may be procured in several ways, as follows: (1) Compounds of standard commercial pigments and dryers may be made by the railroad company, the quality of the ingredients purchased being governed by proper specifications and tests. If this method is followed, all pigments except red lead should be purchased in paste form. Red lead paint should be mixed only in such quantities as are used on the day when mixed. (2) Compounds of standard commercial pigments, oils and dryers mixed ready for use may be purchased from reliable paint manufacturers, provided proper specifications and tests govern the quality of the paint furnished. (3) Proprietary paints may be purchased from reliable paint manufacturers. In this case care should be taken to purchase only those brands which have demonstrated their quality under service similar to that required.

(b) Methods (2) and (3) are advantageous in that the mixtures are made by grinding in mills, and are more uniform. Method (3) utilizes the skill and experience of specialists in making paint, and when the value of the products in service has been established, possesses advantages.

(c) The value of the standard commercial pigments and oils, when subjected to proper specifications and tests, should be known to competent master painters. No recommendations are made at this time as to particular paints or paint materials. In view of the tests and studies being made by a committee of the Society for Testing Materials, with the mutual co-operation of engineers, chemists and manufacturers, it is hoped that practice with respect to the materials of paint will be reduced to a more rational and satisfactory basis.

(5) Season for Painting.—Repainting should be done during seasons of the year when favorable weather conditions prevail, and should not be attempted in freezing or wet weather. It is preferable to permit the progress of rust for a limited time until favorable conditions obtain, rather than incur the risk of failure and loss of labor and materials liable to result when paint is applied under adverse conditions.

(6) Cleaning.—(a) Repainting should be preceded by thorough cleaning of the surface. It is not necessary in all cases to remove the old paint down to the naked metal unless corrosion is proceeding under the old coating. A considerable portion of the old coating often remains intact, though having scattered blisters, which may be removed with wire brushes and scrapers.

(b) In cases where corrosion is proceeding under the coating, or when the paint is of such a character as will not bond to the new paint, the old coating should be cleaned down to the naked metal. For example, a bituminous or asphaltic paint should be entirely removed when a linseed oil paint, or a paint with a vehicle principally of linseed oil, is to be used.

(c) The best results, in cases where the entire removal of an old paint is necessary, are obtained by the sand blast. Portable sand blast machines operated by gasoline engines are convenient for this purpose. The apparatus, when properly proportioned and provided with a suitable tank, would be available for operating a few pneumatic guns for driving rivets, and could be used for either one or the other of these purposes separately, as required. Where humidity prevails it is desirable to cover the sand-blasted surfaces without appreciable delay.

(d) Scrapers should be made of tempered steel, spring steel being convenient for this purpose. A good scraper may be made by grinding a chisel edge on one end and at the other end drawing the temper and bending to the form of a hook about 2 in. long and re-tempering. The end of the hook should be ground to a chisel edge, so that one end of the tool may be used for pushing and the other for pulling. The hook end may be used in striking where it is necessary to remove

(7) Wire Brushes.—Wire brushes for cleaning should have bristles about No. 11 gage and about 2 in. long, and should have reinforced backs.

(8) Workmanship.—Care should be taken to work the paint into all crevices, corners and joints and it should be scale or other adhering matter by blows.
well brushed out and spread evenly in order to expel moisture on the surface. All surfaces so close together as to prevent the insertion of paint brushes should be thoroughly coated by using pieces of cloth or other suitable material. The heads and nuts of new rivets and bolts should receive a coat of paint in advance of the general painting. Care should be taken not to brush out the paint too thin on corners and edges.

(9) Brushes.—Brushes should be of the best quality, and, when used by unskilled painters, should preferably be flat, and, when by skilled painters, should be round.

(10) Special Protection.—When floor systems are exposed to the action of corrosive liquids dripping from rolling stock, recourse may be had to a protecting shield, which may be made of duck and heavy canvas fabric, saturated with materials as nearly as possible immune from the corrosive effects of the drippings, or of wood, metal, concrete, mastics, etc. This subject is being investigated by a special committee (see report of special committee on Brine Drippings).

(11) Smoke Shields.—On the under side of bridges at

crossings over steam roads, when the head room is so low as to subject the metal to cutting by the cinders expelled from the locomotive exhaust, the paint is rapidly destroyed, and should receive the protection of a shield. Wooden shields made in removable sections to facilitate erection and removal for repairs have been found to resist the cutting action of the cinders for an indefinite time. Wood is better than mortar or concrete placed on a steel fabric, since in cases of low head room it will outlast the latter, and is much lighter in weight. The wood should be white pine or a wood of similar texture, capable of receiving and retaining paint. The shield should be made on 1-in. material, dressed all sides, and should receive at least three coats of paint on both sides. All parts to be in contact with other wood or metal should be painted two coats before assembling. A good iron oxide paint will answer this purpose.

(12) Troughs, Etc., Drained.—Troughs or pockets should be drained. Recesses which cannot be drained should be fitted with a waterproofing compound.

(13) Wood Surfaces in Contact.—Both surfaces of wood in contact should always be heavily coated with paint before being placed together. Surfaces of wood placed against metal should be similarly coated. The life of a guard timber, for example, is thereby prolonged.

Conclusion.

Your committee recommends the adoption of the report on Maintenance of Bridges, and its publication in the Manual of Recommended Practice.

The report is signed by J. E. Greiner, (B. & O.), Chairman; C. F. Loweth, (C., M. & St. P.), Vice-Chairman; J. C. Bland, (Penn. Lines); M. F. Brown, (Cons. Eng.); C. H. Cartlidge, (C., B. & Q.); C. L. Crandall, (Cornell Univ.); B. W. Guppy, (Me. C.); A. J. Himes, (N. Y., C. & St. L.); Chas. M. Mills, (Phil. El.); A. D. Page, (Cons. Engr.); C. D. Purdon, (St. L. & S. F.); A. F. Robinson, (S. Fe); C. C. Schneider, (Cons. Engr.); F. E. Turneaure, (Univ. of Wis.); Wm. R. Webster, (Cons. Engr.); J. R. Worcester, (Cons. Engr.).

Discussion.

Mr. Greiner: The committee submit for information only, and as a progress report, the subject of maintenance of bridges, including protection from corrosion. We invite written criticisms on this report, and it will be revised and resubmitted at some future date, in time for the next convention, when we expect to have it in shape for publication in the Manual of Recommended Practice.

A subject that is of the greatest importance, so far as this committee is concerned, is that bearing on impact tests. As you know, there has been a good appropriation made for the purpose of investigating the dynamic effects of trains on bridges. The committee has done a considerable amount of work in this line. Practically all of the tests have been completed, but they are not yet worked out, and I will ask Prof. Turneaure, who is the chairman of the subcommittee in charge of these tests, to outline to the association the work that has been done, what remains to be done and the additional amount of money that is required to bring the work to proper completion.

Prof. Turneaure: Mr. Chairman and gentlemen, it has not been possible to prepare a formal report for this meeting, but in the Bulletin is a brief statement of the work done during the past season, a brief description of the bridges upon which the experiments were made and some statements of the amount of work accomplished. The work has now been going on two seasons. During the summer of 1907 some five weeks were spent in the field and in the summer of 1908 some nine weeks; parties were made up of from six to eight men, Mr. Crandall and myself being in the field continuously, the other members of the parties consisting of assistants, bridge engineers and other engineers on the roads on which experiments were being made. Some forty bridges have been tested, spans being from 50 to 300 feet in length. On each of these structures runs were made with test trains using from two to four different types of locomotives and generally enough loaded cars to test the bridge fully. With these test trains, about 1,600 separate runs were made. During the first summer we had eight extensometers in use, and we obtained something like 1,200 records to tabulate, correlate and bring into final shape. The work has been done on eight different railways; the Nickel Plate, the Santa Fe, the Pennsylvania, the Norfolk & Western, the Northwestern, the St. Paul, the C., B. & Q. and the Rock Island. I may say on behalf of the committee that we are very grateful indeed for the courtesies of the various railway officials concerned and the very great pains that have been taken in every instance to render us every possible service. In many cases traffic has been shunted around our particular piece of track and the very best facilities have been given us in order that the tests could be conducted expeditiously. In working up this mass of material, we have taken up, first, the deflection records, these being somewhat simpler to work up and less likely to individual and erratic variations. The deflection records have been pretty thoroughly worked up, and the committee will determine upon the publication of these records as to facts. It has been impossible to meet and discuss these records as they should be before any conclusions can be drawn, but the records themselves will stand and it was thought they will be of very great value to those who are particularly interested in this subject; so that the deflection records, it is expected, will be published soon as a separate Bulletin. In general, from these deflection records we have found percentages of impact, so called cases of deflection over static deflection, ranging all the way from 15 to 20 per cent over the longer spans up to 80 or 90 or 100 per cent over the shorter spans.

One thing brought out by these tests which may be considered as definitely shown is that for all spans of considerable length, say, 75 or 80 ft. and over, the worst impact effect is produced when the train is going at such a speed that the rate of rotation of the drivers of the locomotive corresponds with the natural rate of vibration of the loaded structure, giving the cumulative effect due to these impulses from the excess balance on the locomotive drivers. That speed, which may be called the critical speed, is very well defined on the longer spans. On spans 200 or 300 ft. in length, that critical speed will be 30 to 35 miles an hour. A lower speed will give very much less vibration; a higher speed will also give less vibration than this critical speed. For shorter spans, less than 50 or 60 ft. in length, this critical speed is less than the ordinary maximum speed at which trains are run. Those facts will appear in the published Bulletin. The extensometer records involve a mass of data which have only been partially worked up, and the working up of the analysis and correlation will take considerable time. We expect to get all of this in form for final report next year, but it will take the greater part of the year to accomplish this work. It is quite likely that we should, in order to round up the work, make experiments on a few more bridges, probably some spans longer than those already tested. The longest span yet experimented upon is 300 ft. It will be of very material assistance to get a few points beyond that length, 400 and 500 ft. spans if possible.

Incidental to this main work, we have by means of the extensometers, got some interesting information on the secondary stresses, but that work has been purely incidental. It was thought best to confine ourselves to the main problem and not take time going into secondary stresses, although it is an important subject. The committee has spent practically all of the appropriation of $5,500 for the two years. The expenditures have been in general for the following purposes: The cost of the instruments, repairs, and so forth, has been about $2,500; about $1,000 has gone back to the railway companies for railway fare; the salaries of assistants in the field and in working up the data have amounted to about $1,800.

The work is not as complete as we hoped it might be at this time, but I think our field work has covered somewhat more ground than we expected to be able to cover when we started on the work. I think it is safe to say that the results, from all of the experiments, when brought together, will give information that will be very well worth the cost of the work. To complete the tabulation and digesting of data will require some additional expenditures, and if we could at the same time have some sufficient funds to make a few supplementary tests in the field, I am sure it would add to the value of the report very much more than the relative cost of the additional work. The matter was discussed at the meeting of the Iron and Steel Committee Tuesday afternoon. I take it from the suggestion of the chairman that I am expected to state to the convention the results of that discussion, as to what funds we thought we ought to have to complete this work in proper shape. The conclusion we reached was that we should have an appropriation of about $3,000 to get the work done in the best way and to make it of the most value to the association. The data that we have at hand now can be rounded up and presented by an expenditure of somewhat less than this, but I think the larger expenditure would be very amply justified and would enable the committee to present a much more satisfactory report. It is expected that the published data relative to deflections and impact as deduced from the tests will be gotten together promptly, so that we can have the use of the data. It is not expected to publish conclusions or discussions, but to

publish facts, which will remain facts no matter what the discussion may be later.

Hunter McDonald (N. C. & St. L.): In order to get the matter before the convention I desire to offer the following resolution:

"Resolved, That it is the sense of this association that the impact tests be pushed to a conclusion and that the matter be referred to the Board of Directors to find means for doing so."

In offering this resolution, I assume that the committee are of the opinion that these impact tests should be pushed further.

The Vice-President: I so understand the wish of the committee.

The motion was carried.

The Vice-President: The matter will be taken under consideration by the Board of Directors. The committee presents a conclusion in regard to the maintenance of bridges, but I understand from the preliminary remarks of the chairman that he presents this report for information only, as a progress report, designed to get written discussion from the members.

ALLOWABLE LENGTH OF FLAT SPOTS ON CAR WHEELS.

The Board of Directors instructed the committee to "continue investigations in regard to injury to bridges and railroad structures caused by flat spots on wheels, conferring with committees of other associations."

A meeting of the Arbitration Committee of the Master Car Builders' Association was held in Chicago April 29. Your sub-committee was invited to attend the meeting, but the chairman alone was able to be present. The immediate business before the meeting was supposed to be a discussion of the statistics of the renewal of car wheels which had been gathered at the request of the Arbitration Committee during the months of January and February. It appeared, however, that the Arbitration Committee had changed its attitude upon the subject since its last meeting and announced that the subject was not a question of economy at all; that if any given flat spot was dangerous it should not be permitted, and if not dangerous, there was no need to consider it, and that the committee had no jurisdiction in the matter and could take no cognizance of the subject except upon the presentation of specific evidence of such danger. This was truly an arbitrary position, especially as the Master Car Builders' Association had fixed the 2½-in. limit 30 years ago, with no specific data and would now volunteer no effort to determine the safety of that limit for high-capacity cars. It had been hoped that the statistics collected would shed some light upon the expense involved in a reduction of the limit, but the committee declared them to be of no value whatever and even misleading, and declined to permit their use in the discussion.

After this decision of the Arbitration Committee, the only course remaining was to gather such existing information as could be obtained from the membership of our association.

Accordingly a circular letter was sent out and 60 replies were received. Of these, 38 indicated no knowledge of any rail breakages due to flat spots on wheels, 11 indicated the possibility of such breakages and 11 recounted experiences more or less specific which, as a whole, indicate quite conclusively that rails have been broken by flat spots, although the spots were generally more than 2½ in. in length and under a locomotive or tender. Since the 11 replies last mentioned constitute the whole tangible evidence of injury by flat spots and are in themselves of much practical interest, extracts therefrom covering the desired information are appended to the report.

The letter of Mr. Purdon (Frisco) is reported in full because his investigation reveals a typical situation as to the state of knowledge of the effect of flat spots. Mr. Cushing contributed a mathematical discussion of the subject by his assistant, Mr. Stetson.

Some work on the measurement of the impact of flat wheels on bridge structures was done during the summer, and the results will probably appear in the report of the Sub-Committee on Impact Tests.

Inasmuch as the Arbitration Committee of the Master Car Builders' Association had disclaimed any jurisdiction in this matter, the Executive Committe of the Master Car Builders' Association referred the subject to the Committee on Car Wheels. This committee held a meeting in Buffalo, Nov. 7, at which your sub-committee was represented by its chairman. The subject of flat spots received a very thorough discussion at this meeting and the chairman agreed to furnish your sub-committee copies of the statistics relating to the renewal of wheels which were gathered in January and February, 1908. These statistics were collected by eight different railroads, namely: Michigan Central, Delaware, Lackawanna & Western; Nashville, Chattanooga & St. Louis; Southern Pacific; Union Pacific; Chicago, Milwaukee & St. Paul; New York, Chicago & St. Louis, and New York, Ontario & Western. They show the actual number of pairs of wheels renewed because of flat spots; also the number of pairs of wheels having flat spots 2 in. in length and over, but below 2½ in. and the number having flat spots 1¾ in. and over, but below 2 in.

These statistics have been combined in the following table:

Capacity of cars.	1¾ in. and over but below 2 in.	2 in. and over but below 2½ in.	2½ in. and over.
40,000 lbs.....	283	209	211
60,000 lbs.....	1,159	1,244	957
80,000 lbs.....	711	669	540
100,000 lbs.....	573	525	304

Since we are concerned more particularly with cars of 100,000 lbs. capacity, if a limit of 1¾ in. had been in force, the number of pairs of wheels renewed under cars of this capacity would have been 1,402 instead of 304 with the 2½-in. limit, an increase of 362 per cent. It would be very interesting to know whether flat spots develop more rapidly under 100,000-lb. cars than under cars of lighter capacity, and the relative number of cars of each capacity in service. No such information is now available.

The Car Wheel Committee decided by unanimous vote that the present 2½-in. limit is entirely sufficient and that no measurements to determine the impact are necessary. The opinion was expressed that the evidence submitted was not sufficient to show that the 2½-in. limit was too high, and until that had been conclusively proven, the committee would give the matter no further consideration.

We repeat here what was said in the discussion at the last annual convention, that the energy expended in the blow from a flat spot can be measured, and by comparing it with the energy required to break a rail under the drop test a factor of safety may be determined that will afford an entirely rational means of selecting a limit for flat spots.

The report is signed by Albert J. Himes (N. Y., C. & St. L.), Chairman; A. D. Page (Cons. Eng.), and C. D. Purdon (St. L. & S. F.).

Discussion.

J. E. Greiner (B. & O.) spoke for the committee. He said: "This was a report that was continued over from the year before and it has been investigated as far as the members of this committee feel that they are justified in going. We think that it is properly a subject for investigation by the Rail Committee and have so recommended in this report. We recommend that the subject be referred to the Rail Committee and the investigations be continued on account of their importance."

L. C. Fritch (I. C.): It seems to me that the Rail Committee would not be exactly the committee to handle that subject, because injury is also done to structures and bridges. It seems to me it would be better handled by a special committee or possibly by a joint committee of the Rail Committee and the Iron and Steel Structures Committee.

The Vice-President: You would suggest that it be handled by a sub-committee, or by the Iron and Steel Structures Committee directly? What would be the opinion of the committee as to handling that matter themselves further?

Mr. Purdon: The chairman of the committee had several meetings with the M. C. B. Association, but could not reach any results and they finally turned it down cold, saying they were perfectly satisfied with 2½ in. flat spots. We then attempted to get data on what the additional cost would be of reducing the flat spots to 1¼. We have not succeeded in getting that yet, and all the information we can get from operating officials was generally more their judgment than accurate data, though we did secure a good many cases of broken rails that we actually traced to a flat spot on a wheel. The committee could continue to get the data, but I do not think it would be practicable for them to reach any result with the M. C. B. Association, as that association declined to have anything further to do with it. As the impact of the flat spot goes to the rail first, we are of the opinion that it ought to go to the Rail Committee first.

The Vice-President: Is there anyone here who can tell us whether the matter has ever been handled by the American Railway Association in any way? Do I understand that the committee on Iron and Steel Construction decline to handle the matter further? Of course, compilation of further data is not reaching a conclusion.

Mr. Greiner: The committee do not decline to handle the matter. We are perfectly willing to continue it as far as we

can go, but we feel that so far as working with the M. C. B. Association is concerned, nothing more can be done. We also feel that it could be more properly handled by the committee which is studying rails than by the committee on Iron and Steel Structures. If the association desires us to continue further, we are quite willing to do so. If the association is indifferent about the matter, we prefer them to let some other committee continue the investigations to a conclusion if they can.

Mr. Fritch: The circular issued to the Board of Directors was to the effect that these investigations be made in regard to injury to bridges and railroad structures caused by flat spots on wheels, conferring with committees of other associations. It seems to me that that is a very important branch of the subject and one which the Rail Committee could not properly handle. This might be a very live subject to be investigated with reference to impact on bridges, and it seems to me that at the same time they were making those tests they could make tests of wheels with different flat spots and determine the effect on the structures.

Mr. Greiner: We would be quite willing to make the experiments if we could find some railway that would furnish us with cars with flat wheels and allow us to run the cars over the bridges at any speed. That is the only way we can find out, unless we just happen to catch a car with a flat wheel when we have our instruments on the bridge; sometimes we do that.

Mr. Fritch: I think the railways are sufficiently interested to furnish cars with the flat spots. They have plenty of them. They furnish them now without any request.

C. H. Cartlidge (C., B. & Q.): It is true that it would be possible to investigate the subject from the point of view Mr. Fritch mentions, if the work did not preclude the doing of one in doing the other. We cannot carry out our impact work exactly at the same time we are making tests for impact of flat wheels. They are two different propositions. One should not be included in the other. The trials for the effect of flat spots will vitiate a good deal of the data for impact. They should be kept separate. It follows that in order to carry out such experiments we should have a double appropriation, to carry on a different series of tests. I think the committee will undertake the work if the association desires.

Prof. C. F. Allen (Mass. Inst. Tech.): It seems to me this work is a matter that can very properly be left to the Board of Directors, and I move that it be taken care of in that way

The motion was carried.

UNIFORM GENERAL CONTRACT FORMS.

The special committee presented a progress report.

The report enumerates the essential elements of a binding contract, as well as the components of a uniform general contract to be used with construction or engineering operations. The general conditions are grouped under 20 different headings, and these in turn are expanded into various sub-heads on which the committee asks discussion in the convention as a help in the final preparation of the "general conditions" form.

The committee presents a proposed uniform general contract form embodying the requirements established for the first component, the "agreement form." The report concludes with a list of marginal headings for the general contract form.

The report is signed by W. L. Breckinridge, (C., B. & Q.), Chairman; E. F. Ackerman, (L. V.), Vice-Chairman; J. C. Irwin, (N. Y. C.); W. S. Kinnear, (M. C.); E. H. Lee, (C. & W. I.); W. A. McGonagle, (D., M. & N.); W. F. Tye, (Con. Eng.).

Discussion.

Mr. Ackerman: In the absence of our chairman, Mr. Breckenridge, and a few others of the committee, I shall assume to take charge of the committee and present this report to the association. In presenting this report, it is with the understanding that it is only a progress report. At the outset the committee was unable to agree as to what form the information in hand should be put in. We finally came to the conclusion that we should start upon a fundamental basis. At this time, in presenting this report, the committee does not feel it has any conclusions to present, but the principal desire is to have expressions from the members so as to assist in future work. We have presented several definitions; for instance, a definition defining a contract; likewise a definition covering specifications. These were given some thought, but I would like to have this placed before the association and see whether these definitions are satisfactory to it.

L. C. Fritch (I. C.): I move that these definitions be approved.

Motion seconded.

A. S. Baldwin (I. C.): Before that motion is put to vote, I would suggest the elimination of the words "either written or printed." Of course we would wish that all contracts be written or printed, but a verbal contract that is proven is just as much a contract. I doubt the wisdom of excluding from the provision a verbal contract.

The Vice-President: You suggest omitting the words "written or printed?"

Mr. Baldwin: I suggest making it read: "A formal agreement, either verbal, written or printed." However, verbal would not be a formal agreement. Again, if you are going to specify a verbal contract it would be necessary to have it proven. It seems to me it would be better if "either written or printed" be omitted.

Mr. Ackerman: I do not consider that it is the desire of a railway corporation to have very many verbal contracts, but as this is a general definition defining a contract I would favor the acceptance of it by the committee.

The Vice-President: The motion is now before us as to the acceptance of these definitions as amended.

The motion was carried.

The Vice-President: The chairman will explain the features of the essential elements of a binding contract, found in the report.

Mr. Ackerman: Before proceeding with the development of a contract form, the committee thought well to know what the essential elements of a binding contract were. We referred to a number of sources on this subject and give the essential elements as expressed by John C. Waite and J. B. Johnson, and also the elements as reported on by the committee on Buildings, volume 5 of Proceedings, page 3762. The committee would like to have an expression from the association as to which of these three definitions, so to speak, cover the expression of a binding contract more properly. It should be clear and at the same time as brief as possible.

M. L. Byers (Mo. P.): There is one very important matter in connection with contracts that I imagine has caused all of us a good deal of trouble and thought. That is the liability clause in contracts. It is becoming possibly more important on account of the tendency to change the laws governing questions of liability and to increase the liability of employers for personal injury in particular. It seems to me it would be very advantageous if the committee would, in connection with its next year's work, take up the liability proposition and enunciate the principles governing the dividing of liability between the company and contractor, and also to keep in mind in that connection the possibility on the part of the contractor of securing insurance against the liability which he assumes under the contract.

Mr. Fritch: It seems to me we are getting outside of the province of engineering in discussing questions of this character. The essential elements of a binding contract are not the same in the various states of this country, and no matter what we may say here as to what should be the essential elements, they would still be subject to the approval of our respective legal departments. Therefore, it seems to me we are taking up a question that is outside of our jurisdiction. I think it is all right for us to specify as to technical details, but when it comes to a question of what is a legal and binding contract, that is a question of law.

Mr. Byers: I do not entirely agree with Mr. Fritch in regard to his conclusions, although I do in regard to the facts. It is a question of law in regard to the points which I brought up, but unfortunately it is a part of every contract, and this committee is endeavoring to aid the members in deciding on what should be a uniform contract form. As to the laws in different states, the committee might aid the association by doing some tabulating of those laws, but I don't know how far it would be advisable to go into that. The point I have specially in mind might be illustrated in this way: We had a contract recently in which the form was pretty stiff in regard to placing the responsibility on the contractor. The contractor said, "Well, we could resign this contract, possibly, because we don't think it is legal, but we don't think that is a very good plan. At the same time, we cannot afford to take risks which we cannot cover by insurance." The question is not entirely in that way a legal question. It is a question as to what extent the insurance on different classes of liability can be secured.

Prof. Dufour (Univ. of Ill.): It seems to me that the fact that "lawful subject matter" is given as an essential of a contract covers the question under consideration. It depends upon the existing circumstances as to whether the liability clause would be legal or not. Almost every state

would, in every case, look upon it under a different consideration.

Mr. Ackerman: I cannot quite agree with Mr. Fritch's remarks. I believe that the fundamental or essential elements of a binding contract are generally as stated and that they are the same in almost every contract. We must know along what lines we must work, and if we have not these the results might be at random. I appreciate that the legal departments of all railways will ultimately pass upon any contract turned out by the committee, but I believe in the elementary features. We can hew closely to the line and turn out something satisfactory.

Prof. Allen: The report mentions that one of the essentials of a contract is that there be competent parties. The definition we have passed specifies that it is between two or more parties. Possibly that is a slight inconsistency in wording that the committee take into consideration.

The Vice-President: We will pass on to the next: "Components of a Uniform General Contract Form."

Mr. Ackerman: With a view of preparing a uniform general contract form, the committee has thought well to determine the components of such a form. In a general way, there are two components, so far as we have been able to determine, one being indicated "A," which is a proper agreement form, and "B," a statement of general conditions applicable to all classes of construction operations. Our idea in separating these was to prepare the form "A" first and embody in it such wording, in the shape of an agreement form, as could be applicable to almost all kinds of agreements. Then, instead of having general conditions incorporated in that agreement form we have separated them from the usual agreement form and made a separate statement, which we will call a General Conditions form. That has been tried out, particularly so on the Lehigh Valley. We found it would cover many cases. The components of "A" and "B" we have further amplified as follows: First, an introductory or opening clause. Second, a complete statement and description of all parties to the agreement. Third, a concise description of the subject matter, in other words, a description covering the nature and the location of the work to be performed, or furnished, for a consideration. Fourth, a statement of when (sometimes under what conditions) the contract becomes operative and the limit, if any, for duration of the contract. Fifth, a statement of the documents accompanying the contract. Sixth, a clearly defined statement of the payment or consideration. Seventh, a proper form of attestation, which should cover the signatures of all the parties to the contract, etc.

The committee presents herewith for discussion such an agreement form. This form has been used in actual practice and is substantially the same form the Lehigh Valley used. It has been found quite flexible. Compared with other agreements or contract forms, the wording is substantially the same, but its general arrangement and shape in this form is presented and I should be glad to have it considered by the association.

The Vice-President: Any suggestions should be sent by the committee in writing.

Mr. Ackerman: The general conditions statement is intended to generally accompany agreement form "A" and covers the general conditions usually stipulated in contracts, which I have grouped under twenty headings. I believe that they cover pretty nearly everything that should, and usually does, enter into an agreement. I would say that it was the intention later on, after we are satisfied with this grouping and statement of headings, to amplify them to the general conditions statement. It is the intention also to exclude from the general conditions statement anything of a specific nature. The point raised heretofore by the gentleman on the liability will be included on this general conditions statement.

J. O. Osgood (C. of N. J.): I notice that in the contract blank prepared form, which is simply a skeleton, that reference is made, after the first long blank, to the plans. It says, "In accordance with the plans hereto attached, or as hereinafter described and forming part of this agreement." I notice there is no reference to the specifications. There is no attempt in this form to give the contract in full, but it occurs to me that the specifications should be referred to also. The specifications are usually an independent document attached to the contract and forming part of it.

Mr. Ackerman: You will find there a statement that the work shall be done under the direction of the engineer of the company and in accordance with the plans, the following conditions, requirements and specifications.

The Vice-President: Mr. Osgood would suggest that the specifications should be referred to at the same place the plans are referred to. The committee will take that under consideration.

W. G. Brimson (Q. O. & K. C.): I would like to inquire of the committee what their interpretation of the word "capacity" is, in the phrase "two parties of capacity to contract."

Mr. Ackerman: I understand legal capacity.

Mr. Brimson: I submit that the committee should take into consideration whether the parties are able to perform. A decision has lately been made, that where parties contracted to do certain work which it was obvious they could not perform, they would be relieved of that obligation. That is to say, if a party should contract to build a bridge, he could easily build a bridge by subcontracting or in some other way perform his obligation; but if he should contract to build a ladder to the moon, it was obvious he couldn't do it, and hence, however much he might contract, the contract would be void. I believe that should be taken into consideration.

Mr. Ackerman: There is another essential element comprising a binding contract, which, according to Mr. Waite, is "a lawful subject matter, whether it be a promise, an act or a material object." It doesn't seem to me that building a ladder to the moon would be a material object. However, that might better be covered by saying "a legal or possible subject matter."

Mr. Brimson: I believe that would be better. Of course my ladder to the moon was simply to show the extremity.

S. E. Coombs (N. Y. C.): I would like to inquire whether it is possible to have these forms on letter size sheets, or whether there has been any previous action that would prevent this.

Mr. Ackerman: I hardly think that that would be a desirable form in which to present the agreement form, the idea being mainly that this form will act as a cover to a contract in which sheets or letters can be incorporated. Likewise, in the case of a small agreement, where you have to use an agreement plan, that plan can be placed in the agreement and form a part of it.

Mr. Coombs: Isn't the usual small agreement plan of such a size that it will fold over once and be letter size?

Mr. Ackerman: As a general proposition, all of our specifications are not letter size. They are usually on legal size paper. Of course, there is no objection to any railway adopting any size to suit its own convenience.

E. F. Wendt (P. & L. E): I move that this report be heartily approved as good information.

Motion seconded.

Fred Lavis (P. T. & T.): I might say for the information of Mr. Coombs, that all the contracts of the Pennsylvania Railroad tunnel extension in New York city have been made on what is practically letter size.

Prof. Allen: There seem to be two very distinct ways of reaching the specifications as part of the contract, that is, in many contracts a reference is made to the specifications "which are hereby made part of this contract," but there are many engineers in lines of municipal work who much prefer to have specifications included as a part of the contract. There are certain agreements oftentimes in specifications that are in the nature of contracts, and I would like to suggest that the committee consider those two types of contract as they take the matter up during the coming year.

Mr. Ackerman: It is the purpose of the committee to further consider that matter and, in fact, the committee has given it some consideration already. As a general proposition, we will cover that by drawing up a special condition sheet, typewritten or printed sheet, to accompany the contract for concrete masonry, or reinforced concrete masonry, or something of that kind. If possible, a great deal of consideration will be given to that subject so as to get it in a sort of standard form.

C. P. Howard (L. S. & M. S.): In a recent form of contract, with which I have had something to do on the Lake Shore, in drawing up the contract I think these words in regard to the specifications were included in the title, speaking from memory: "The plan and specifications are hereby declared to be a part of this contract."

The President: The motion before the house is that this report of the committee be received as information.

Motion carried.

MASONRY.

Sub-committees were appointed as follows:

(A) To co-operate with the "Joint Committee on Concrete and Reinforced Concrete."

(B) Collect data upon the reported failure of concrete structures and the probable cause of same.

(C) Investigate and report upon the waterproofing of ma-

sonry, covering methods, results, cost and recommended practice.

(D) Report on the use of reinforced concrete trestles, typical designs, cost and recommended practice.

(E) Present typical plans of retaining walls and abutments, plain and reinforced, with comparison and recommended practice.

(F) Report on the desirability of all monolithic construction in arches or large abutments with wing walls.

(G) Submit specifications for reinforced concrete.

Monolithic Construction in Arches or Large Abutments with Wing Walls.

A circular containing the following questions was sent to members:

1. (a) Is it your practice to build abutments with wing walls as monolithic structures, and to what limits as to height, if any? (b) If you build abutments in sections, what would be your maximum length of section for plain concrete and for reinforced concrete?

2. (a) Is it your practice to build arches with wing walls as monolithic structures? (b) If you build arch abutments in sections, what is your maximum length of sections? (c) In plain concrete and in reinforced concrete?

3. (a) Is it your practice to build up arch rings parallel with the axis of the arch? (b) Is it your practice to build the arch ring transversely to the axis of the arch, making joints between separate sections? If so, what would be your length of section for (1) plain concrete and (2) for reinforced concrete?

4. Please describe any failures that may have come under your observation of abutments with wing walls as monolithic structures to retain that characteristic, i. e., have the wings cracked away from the body of the abutments, or the abutments cracked in any way? State height of abutment and approximate length of the top of wings on the abutments and type of wing wall.

5. Please describe any failures that you may have observed of arch rings built as monolithic structures to retain that characteristic, giving thickness of wings, length and, if possible, manner of construction.

A summary of the replies shows that for bridge and arch abutments the majority use monolithic construction. In reinforced concrete the maximum sections run from 30 to 300 ft. for bridge abutments and 50 to 300 ft. for arch abutments.

Sixteen roads build arches parallel with the axis and 15 at right angles to the axis.

Cracking of the concrete is, as a rule, due to settlement in the foundation. Several report cracking due to inferior quality of material, and several that the cracks were traceable to the lack of expansion joints.

Instances of failures of abutments are of interest. One pair, 176 ft. long and 56 ft. high, broke into about three equal parts, due to settlement. Some monolithic abutments on alluvial soil and pile foundation are subject to heavy freshets. One, 33 ft. high, was scoured to a depth of 10 ft. underneath. It moved forward 14 in. and settled about 2 in. without a crack. If it had been built in sections it would no doubt have failed. Another 22 ft. abutment on sandy soil without piling scoured underneath and the abutment settled 2 ft. without cracking. The girder was blocked up and trains continued running over the abutment.

In the case of arch abutments, cracking very often occurs where the foundation is on piling or on poor foundation on account of the earth pressure being much greater at the center than at the ends. These cracks may open up an inch or more. They are unsightly, but not dangerous, and are not often the cause of a failure.

Retaining Walls and Abutments.

Your committee has collected information bearing on the practice of railroad companies in retaining-wall design. Diagrams giving dimensions of a number of representative retaining walls are included in this report, together with some description and comment. The answers to the letter of inquiry show that the practice of using arbitrary ratios of width of base to height of walls is general. These ratios are very variable and generally no attempt is made to calculate the earth pressure back of the wall in order to determine the direction and position of the resultant pressure on the foundation. The term, "width of base," is used by some to designate the extreme width of the lowest footing of the wall and by others the "neat work" above the footing, a difference in usage which has been the cause of much confusion.

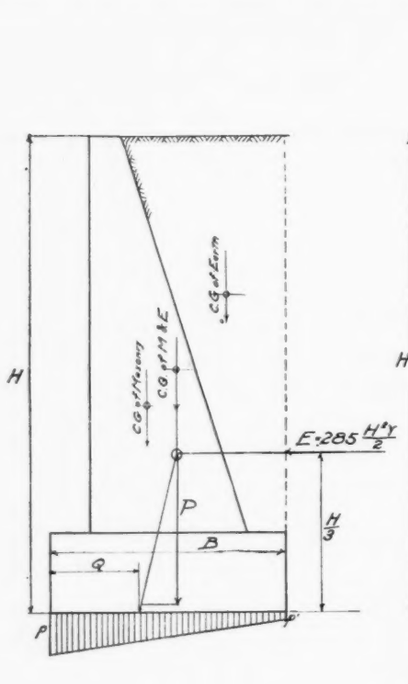


Fig. 1.

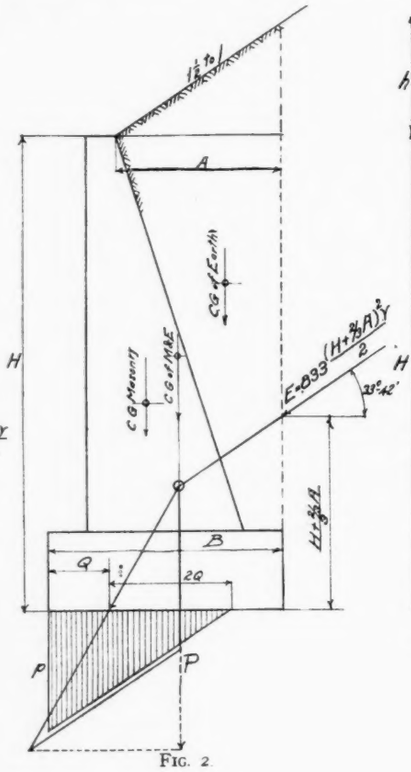


Fig. 2.

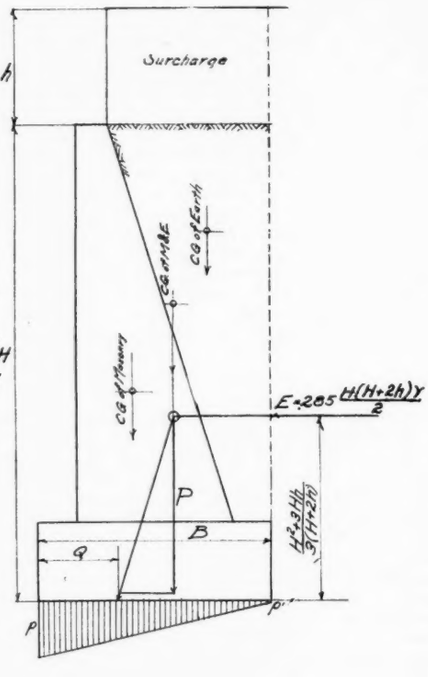


Fig. 3.

The use of a fixed ratio of width to height, which seems to be common practice, leads to a neglect of the study of the distribution of the pressure on the foundation. This is a question of great importance, since it is well established that movements from the original alinement, due to unequal settlement, form a defect more common than any other. The introduction of reinforced concrete retaining walls adds another reason for requiring an anlysis of the forces and pressures. The committee therefore feels that attention should be called to the importance of making a study of each case,

and particularly of the amount and distribution of the pressure on the bed or foundation.

Notwithstanding the importance of an analytical treatment, the committee deems it proper to add a word of caution on the acceptance of existing formulas, with the constants usually quoted, without further investigation. There is a feeling in some quarters that the direction and amount of the resultant pressures and the distribution of the pressure over the bed are not well represented by some of these formulas. If these doubts have a sound basis, some of the present tendencies in retaining-wall design are open to criticism. The committee hopes to present a fuller discussion in a later report and possibly to obtain information on the pressures developed.

Meanwhile the committee submits the following method, which is widely published and frequently used for determining the pressures on the back and on the foundation of retaining walls. It is based on the well-known Rankine formulas, which consider that the earth is a granular mass with some assumed or determined angle of repose. In applying this method it is immaterial whether the force representing the earth pressure is considered as acting directly on the back of the wall or if it is considered as acting upon a vertical plane passing through the extreme back of the footing. In the latter case the force representing the lateral earth pressure must be combined with (1) the vertical force representing the weight of the earth prism between the back of the wall and the vertical plane considered, and (2) combined with the vertical force representing the weight of the wall itself.

If the angle of repose of the earth is assumed as 1½ to 1, the force per linear foot of wall, representing the resultant of the earth pressure back of the wall acting on the vertical plane referred to, will be as shown on the diagram Fig. 1 for the case of the top of the fill level with the top of the wall; and diagram 2 for the case of the fill sloping up from the top of the wall at an angle of 1½ to 1 indefinitely. In all cases y = the weight of a cubic foot of earth, H being taken in feet.

If, in addition to the weight of earth, the wall is to support a track load, then the earth pressure by this same method will be that indicated by the diagram Fig. 3.

In all cases the pressure on the foundation by this method will be determined by the following formulas:

When Q is equal to or greater than $\frac{B}{3}$:

Pressure at the toe $=(4B-6Q)\frac{P}{B^2}$;

Pressure at the heel $=(6Q-2B)\frac{P}{B^2}$;

When Q is less than $\frac{B}{3}$:

Pressure at the toe $=\frac{2P}{3Q}$.

Where P = the vertical component of the resultant pressure to the base.

B = the full width of the base at feet.

Q = the distance from the toe to where the force P cuts the base.

The above method seems to be as rational as any that the committee can present at this time. The constants given apply only to earth that will stand on a 1½ to 1 slope, and it must be borne in mind that the pressure on the foundation should never exceed the safe bearing pressure on the material considered.

Means should always be provided for draining the earth back of a wall, otherwise the wall will be subjected to hydrostatic pressure, which will greatly increase the lateral thrust.

The foundation for a wall should always be placed below frost. Usually a wall designed to resist overturning will be secure against sliding on its foundation, but this feature should receive careful attention. The frictional resistance on the base, combined with the abutting resistance of the earth in front of the wall, must be greater than the horizontal thrust of the earth back of the wall, in order to prevent sliding of the wall on its foundation.

A brief review of some of the wall sections reported to the committee follows. Cross-sections of these walls are shown, all drawn to the same scale, the ratio of the base to height (R) being given under each figure. Cross-sections of some designs that have failed are included and a large number of photographic illustrations of interesting walls and abutments.

Reinforced Concrete Trestles.

The Wabash Railroad has built nine of these structures, aggregating 640 linear feet. These have solid reinforced concrete decks (ballast floor) and thin piers, with relatively shallow foundations. The span is generally 16 ft. and the floor slab or deck 2 ft. 4 in. thick. The piers are 2 ft. thick at the top and have batter of ½ in 12 on each face. Vertical and horizontal reinforcement is placed near the faces. The end supports are in the form of abutments. Some of these bridges have been in place two years. No deterioration is apparent. Reinforced concrete trestles are used entirely by the Wabash to replace wooden trestles where an opening larger than can be served by a 4-ft. pipe is required.

The Burlington has over 2,000 ft. of reinforced concrete trestles in service. About 1,500 ft. are trestles built with reinforced concrete piers and slabs (ballast floor) with spans from 14 ft. to 25 ft., and about 600 ft. are trestles resting on concrete piles with spans from 14 ft. to 16 ft. and with the same type of deck. The piers are from 18 in. to 30 in. thick at the top and have the usual batter. In the pile trestles a double row of piles with a cap of extra width or a thin pier is placed at the end of every fifth span. The reinforced concrete piles used include one cast in forms in a horizontal position, and the Chenoweth rolled pile. The company is extending the use of both concrete pile trestles and pier trestles as rapidly as the wooden pile trestles on the main line require reconstruction. This type of construction is confined to places where the structures are free from excessive drift or ice.

The Big Four in 1906 built two reinforced concrete structures near Lawrenceville, Ill., one 419 ft. in length and the other 189 ft. The span is 20 ft. in the clear. [These were described in the *Railroad Age Gazette*, February 26, 1909.]

The following statements may be of value in forming a general idea of the cost of single-track structures. The Wabash states that in ordinary conditions their trestles cost about $20 per linear foot, plus $500 for the two abutments. If abutments are omitted and a free earth slope is allowed, two additional spans must be provided and the total cost will be increased. The Burlington estimates the cost of the pile trestle at from $30 to $35 per linear foot for ordinary heights. The cost of the structures on thin piers and pile foundations is given as $40 per linear foot and upward. The Big Four gives the cost of their two structures as about $21 per linear foot.

The committee feels that experience with reinforced concrete trestles indicates that these structures will be a durable and satisfactory type for use in replacing wooden trestles of low and medium height under conditions which otherwise warrant the expenditure.

Specifications for Portland Cement Concrete and Reinforced Concrete.

1. Cement shall be Portland, and shall meet the requirements of the standard specifications. (See Manual.)

2. Fine aggregate shall consist of sand, crushed stone, or gravel screenings graded from fine to coarse, and passing when dry a screen having 1¼-in. diameter holes; it shall preferably be of siliceous material, clean, coarse, free from vegetable loam or other deleterious matter, and not more than 6 per cent. shall pass a sieve having 100 meshes per linear inch.

3. Mortars composed of one part Portland cement and three parts fine aggregate by weight when made into briquettes shall show a tensile strength of at least 70 per cent. of the strength of 1:3 mortar of the same consistency made with the same cement and standard Ottawa sand.

4. Coarse aggregate shall consist of crushed stone or gravel, graded in size, and which is retained on a screen having 1¼-in. diameter holes; it shall be clean, hard, durable and free from all deleterious material. Aggregates containing soft, flat or elongated particles shall not be used.

5. The maximum size of the coarse aggregate shall be such that it will not separate from the mortar in laying and will not prevent the concrete fully surrounding the reinforcement or filling all parts of the forms. Where concrete is used in mass the maximum size of the coarse aggregate may, at the option of the engineer, be such as to pass a 3-in. ring. For reinforced concrete, sizes usually are not to exceed 1 in. in any direction, but may be varied to suit the character of the reinforcement.

6. The water used in mixing concrete shall be free from oil, acid, alkalies, or vegetable matter.

7. The metal reinforcement steel shall be manufactured from new billets, and shall meet the requirements of the following specifications, and be free from rust, scale, or coatings of any character which would tend to reduce or destroy the bond.

SPECIFICATIONS FOR STEEL REINFORCEMENT.

8. Steel shall be made by the Bessemer or the open-hearth process.

9. The chemical and physical properties shall conform to the following limits:

Elements considered.	Structural steel.	High carbon steel.
Phosphorus, max..		
Basic	0.04 per cent	0.085 per cent
Acid	0.06 "	0.075 "
Sulphur, maximum	0.05 "	.....
Ultimate tensile strength.	Desired	Desired
Pounds per square inch	60,000	85,000‡
	1,500,000*	1,400,000
Elong., min. % in 8"	Ult. tensile str'gth	Ult. tensile str'gth
" " " 2"	22	
Character of fracture	Silky	
Cold bends without fracture	180° flat†	180° $d=4t$

*See paragraph 16. †See paragraphs 17, 18 and 19. ‡See paragraph 20.

10. The yield point, as indicated by the drop of beam, shall be not less than 60 per cent. of the ultimate.

11. If the ultimate strength varies more than 4,000 lbs. from that desired, a retest shall be made on the same gage, which, to be acceptable, shall be within 5,000 lbs. of the desired ultimate.

12. Chemical determinations of the percentages of carbon, phosphorus, sulphur and manganese shall be made by the manufacturer from a test ingot taken at the time of the pouring of each melt of steel, and a correct copy of such analysis shall be furnished to the engineer or his inspector. Check analyses shall be made from finished material, if called for by the purchaser, in which case an excess of 25 per cent. above the required limits will be allowed.

13. Plates, Shapes and Bars: Specimens for tensile and bending tests for shapes and bars shall be made by cutting coupons from the finished product, which shall have both faces rolled and both edges milled; or with both edges parallel; or they may be turned to a diameter of ¾ in. with enlarged ends.

14. Bars shall be tested as rolled.

15. At least one tensile and one bending test shall be made from each melt of steel as rolled.

16. For material less than $\frac{5}{16}$ in. and more than ¾ in. in thickness the following modifications will be allowed in the requirements for elongation:

(a) For each $\frac{1}{16}$ in. in thickness below $\frac{5}{16}$ in., a deduction of 2½ will be allowed from the specified percentage.

(b) For each ⅛ in. in thickness above ¾ in., a deduction of 1 will be allowed from the specified percentage.

17. Bending tests may be made by pressure or by blows. Shapes and bars less than 1 in. thick shall bend as called for in paragraph 9.

18. Structural steel 1 in. thick and over, tested as rolled, shall bend cold 180 deg. around a pin, the diameter of which is equal to twice the thickness of the bar, without fracture on the outside of bend.

19. Finished material shall be free from injurious seams, flaws, cracks, defective edges or other defects, and have a smooth, uniform and workmanlike finish.

20. Every finished piece of steel shall have the melt number and the name of the manufacturer stamped or rolled upon it, except that bar steel and other small parts may be bundled with the above marks on an attached metal tag.

21. Material which, subsequent to the above tests at the mills, and its acceptance there, develops weak spots, brittleness, cracks or other imperfections, or is found to have injurious defects, will be rejected at the shop and shall be replaced by the manufacturer at his own cost.

PREPARATION AND PLACING OF MORTAR AND CONCRETE.

22. The materials to be used in concrete shall be of uniform quality and so proportioned as to secure as nearly as possible a maximum density.

23. The unit of measure shall be the barrel, which shall be taken as containing 3.8 cu. ft. Four bags containing 94 lbs. of cement each shall be considered the equivalent of one barrel. Fine and coarse aggregate shall be measured separately as loosely thrown into the measuring receptacle.

24. The fine and coarse aggregate shall be used in such relative proportions as will insure maximum density.

25. For reinforced concrete construction a density proportion based on 1:6 shall be used, i. e., one part of cement to a total of six parts of fine and coarse aggregates measured separately.

26. For massive masonry or rubble concrete a density proportion based on 1:9 shall be used.

27. The ingredients of concrete shall be thoroughly mixed to the desired consistency, and the mixing shall continue until the cement is uniformly distributed and the mass is uniform in color and homogeneous.

28. Methods of measurement of the proportions of the various ingredients, including the water, shall be used, which will secure separate uniform measurements at all times.

29. When the conditions will permit, a batch mixer of a type which insures uniform mixing of the materials throughout the mass shall be used.

30. When it is necessary to mix by hand, the mixing shall be on a water-tight platform and especial precautions shall be taken to turn the materials until they are homogenous in appearance and color.

a. Tight platforms shall be provided of sufficient size to accommodate men and materials for the progressive and rapid mixing of at least two batches of concrete at the same time. Batches shall not exceed one cubic yard each, and smaller batches are preferable, based upon a multiple of the number of sacks of cement to the barrel.

b. Spread the fine aggregates evenly upon the platform, then the cement upon the fine aggregates, and mix thoroughly until of an even color. Add all the water necessary to make a thin mortar and spread again; add the coarse aggregates, which, if dry, should first be thoroughly wet down. Turn the mass with shovels or hoes until thoroughly incorporated and all the aggregates are covered with mortar; this will probably require the mass to be turned four times.

c. Another approved method, which may be permitted at the option of the engineer in charge, is to spread the fine aggregates, then the cement, and mix dry, then the coarse aggregates; add water and mix thoroughly as above.

31. The materials shall be mixed wet enough to produce a concrete of such a consistency as will flow into the forms and about the metal reinforcement, and which, on the other hand, can be conveyed from the place of mixing to the forms without separation of the coarse aggregate from the mortar.

32. Retempering mortar or concrete, i. e., remixing with water after it has partially set, shall not be permitted.

33. Concrete after the addition of water to the mix shall be handled rapidly from the place of mixing to the place of final deposit, and under no circumstances shall concrete be used that has partially set before final placing.

34. The concrete shall be deposited in such a manner as will permit the most thorough compacting, such as can be obtained by working with a straight shovel or slicing tool kept moving up and down until all the ingredients have settled in their proper place by gravity and the surplus water forced to the surface.

35. In depositing the concrete under water, special care shall be exercised to prevent the cement from floating away, and to prevent the formation of laitance.

36. Before placing the concrete the forms shall be thoroughly wetted and the space to be occupied by the concrete free from debris.

37. When work is resumed, concrete previously placed shall be roughened, thoroughly cleansed of foreign material and laitance, drenched and slushed with a mortar consisting of one part Portland cement and not more than two parts fine aggregate.

38. The faces of concrete exposed to premature drying shall be kept wet for a period of at east seven days.

39. The concrete shall not be mixed or deposited at a freezing temperature, unless special precautions, approved by the engineer, are taken to avoid the use of materials containing frost or covered with ice crystals, and to provide means to prevent the concrete from freezing after being placed in position and until it has thoroughly hardened.

40. Where the concrete is to be deposited in massive work, clean stones thoroughly embedded in the concrete as near together as is possible and still entirely surrounded by concrete may be used at the option of the engineer.

41. Forms shall be substantial and unyielding and built so that the concrete shall conform to the designed dimensions and contours, and so constructed the leakage of mortar prevented.

42. The forms shall not be removed until authorized by the engineer.

43. For all important work, the lumber used for face work shall be dressed to a uniform thickness and width, and shall be sound and free from loose knots, secured to the studding or uprights in horizontal lines.

44. For backings and other rough work undressed lumber may be used.

45. Where corners of the masonry and other projections liable to injury occur, suitable moldings shall be placed in the angles of the forms to round or bevel them off.

46. Lumber once used in forms shall be cleaned before being used again.

47. In dry but not freezing weather the forms shall be drenched with water before the concrete is placed against them.

DETAILS OF CONSTRUCTION.

48. Wherever it is necessary to splice the reinforcement by lapping the length of lap will be decided by the engineer on the basis of the safe bond stress and the stress in the reinforcement at the point of splice. Splices shall not be made at points of maximum stress.

49. Concrete structures, wherever possible, shall be cast at one operation, but when this is not possible the work shall be stopped, so that the resulting joint will have the least effect on the strength of the structure.

50. Girders and slabs shall not be constructed over freshly formed wall or columns without permitting a period of at least two hours to elapse to provide for settlement or shrinkage in the supports. Before resuming work the top of the supports should be thoroughly cleansed of foreign matter and laitance.

51. In massive work, such as retaining walls, abutments, etc., built without reinforcement, joints shall be provided, approximately, every 50 feet throughout the length of the structure to take care of temperature changes. To provide against the structures being thrown out of line by unequal settlement, each section of the wall may be tongued and grooved into the adjoining section. To provide against unsightly cracks, due to unequal settlement, a joint shall be made at sharp angles.

52. The desired finish of the surface shall be determined by the engineer before the concrete is placed, and the work shall be so conducted as to make it possible to secure the finish desired. Plastering of surfaces will not be permitted.

Conclusions.

Your committee recommends the adoption of the following conclusions:

(1) The use of all monolithic construction in arches or large abutments with wing walls, where practicable.

(2) That the report on retaining walls and abutments be received as information.

(3) That the Specifications for Portland Cement Concrete and Reinforced Concrete be adopted as good practice, and substituted for the Portland Cement Concrete Specifications now appearing in the Manual.

The report is signed by A. O. Cunningham (Wabash), Chairman; W. H. Petersen (C., R. I. & P.), Vice-Chairman; W. P. Boright (N. Y., C. & St. L.), C. W. Boynton (Cons. Engr.), T. L. Condron (Cons. Engr.), Richard L. Humphrey (Cons. Engr.), H. H. Knowlton (C., C., C. & St. L.), J. M. Meade (A., T. & S. F.), C. H. Moore (Erie), R. K. Rochester (Van), F. E. Schall (L. V.), J. W. Schaub (Cons. Engr.), G. H. Scribner Jr. (Cont.), G. F. Swain (M. I. T.), A. N. Talbot (Univ. of Ill.), G. H. Tinker (N. Y., C. & St. L.), Job Tuthill (P. M.).

Discussion.

The President: In the absence of the chairman the vice-chairman, Mr. Petersen, will make the statement for the committee.

Mr. Petersen: The committee was assigned to work on seven subdivisions. The first subdivision was in connection with the joint report with the American Society of Civil Engineers, the American Society for Testing Materials, the Association of the American Portland Cement Manufacturers and this association. That committee made a progress report in the fall of 1908. It has taken that report and revised the concrete specifications and added to it specifications for reinforced concrete.

The sub-committee that was appointed to report on the failure of concrete structure collected various data in regard to a great number of failures, but it was not in such shape that we could make a report to the convention.

The report on waterproofing of masonry was a progress report, and that subject should be continued in the coming year.

As to the report on reinforced concrete trestles, the committee felt that there was not enough done by the different railroads of the country to make a definite report. But they have made a progress report showing how much has been done by the several roads which we have considered, and about what it has cost these roads to do the work.

As to the report on retaining walls and abutments, the committee has shown the various designs used by the different railroads in the country, and also shown a method of calculating the pressure upon the foundation. The committee does not feel that this is a concrete formula, and if we had sufficient data there is no question that this formula would be revised.

The report on the desirability of monolithic construction was made, as you will find in the conclusion, and the specifications for reinforced concrete had been revised and will be found in the conclusions.

The President: The chair will ask the secretary to read the conclusions in order.

The secretary read conclusion 1.

C. F. Loweth (C. M. & St. P.): I move that the recommendation of the committee be not concurred in. My reason is that the case does not seem to be conclusive. On the preceding page there are 37 railroads that report their practice, and only 17 of them are using monolithic construction. In the case of arch abutments, 34 railroads report their practice, and only 14 have a practice that conforms with the recommendations of the committee. The recommendation may be all right for certain kinds of structures, but it would be very much wrong for other designs of construction.

Mr. Petersen: The whole question hinges upon the definition of the word "monolithic." If you consider a monolithic construction as one that is continued over four or five days of work, and each portion as a part of that which was put in the day before, possibly we should change the definition; but the committee has considered that "monolithic" should really be the amount that is put in in any one operation. You could not very well, in an abutment or retaining wall, put in over 50 ft. in one continuous operation unless you were working day and night continuously, and in that event we felt that the word "practicable" would cover the case and would stop at a limit of about 50 ft.

C. P. Howard (L. S. & M. S.): I ask the committee whether this conclusion 1 means that concrete arches of large spans should be built in voussoir or not—along radial line in voussoir or not?

Mr. Petersen: I should say not, as a rule; one operation would mean one day's work, and you would have a definite separation at the end of each day.

Mr. Howard: My opinion is that it is generally considered better practice, with arches of large spans—over 15 ft.—to build the arches in pairs and along radial lines. I would like an expression of opinion from others in regard to that.

Mr. Petersen: The report shows the roads were about equally divided, that one-half built the arch ring with the concrete at right angles to the axis, each operation being a day's work, and the others laid the concrete parallel with the axis.

C. H. Cartlidge (C. B. & Q.): Inasmuch as the settlement of this question depends largely on the word "monolithic," I would urge that the motion be carried and the recommendation be not adopted until such a definition of the word "monolithic" can be set before us as will remove all doubt as to the meaning of the word.

The President: It is moved and seconded that conclusion 1 be stricken out.

(The motion was carried.)

The secretary read conclusion 2.

Mr. Cartlidge: I move that conclusion 2 be received and approved.

The President: It will be, if there is no objection.

The secretary read conclusion 3.

J. O. Osgood (C. of N. J.): I move that conclusion 3 be rejected and the matter be referred back to the committee.

The President: I think it will aid the committee considerably if there was a little discussion on the motion, giving the reasons for it.

T. L. Condron (Cons. Engr.): As the committee has spent quite a little time on that specification, and as the committee does not have in its membership some of the engineers that are deeply interested in this subject, I am sure that even without the adoption of this specification, it might be valuable for the association to give some consideration to the paragraphs of the specification at this time, not necessarily every paragraph, but some of the more important ones, for the guidance of the committee in any revision of the same.

R. L. Humphrey (Cons. Engr.): I would like to say in connection with the preparation of the present specification, that the Manual was followed as a guide and those portions of it which did not appear to be up to date were modified as they appear here. In some cases the paragraphs were not changed.

As far as the specifications relating to concrete are concerned, if the members of the association have any objection to them, we think it is due the committee that those objections be stated. The specifications as they exist and as they apply to Portland cement concrete I believe are good, and if they are not good, then it will not do any good to refer the matter back to the committee, and we, therefore, think that those who object to them should criticise them in detail; otherwise, how can the committee hope to make any

progress? If that is not done, we will come back next year with the same specification.

In the matter of the specification for steel, perhaps there may be also an equal chance for discussion and expression of opinion that will be a decided service to the committee as expressing the feelings of the members of the association on that important point. I hope the members will freely discuss these specifications in order that we may find out wherein there is objection to them.

L. C. Fritch (I. C.): In seconding the motion to refer this back, I do not wish that to be understood as any criticism on the committee's work, which is excellent, but this Bulletin containing the specifications was not in our hands in sufficient time for us to analyze the specification. I think we shall have time to thoroughly digest them. I think it would be a good idea to take up these important paragraphs and discuss them here, but I do think the association should have time to thoroughly digest these specifications before adopting them.

Mr. Osgood: In making the motion to refer the matter back, it was without any idea of showing any lack of appreciation of the work done by the committee, which has been excellent, but because it seemed to me that what was presented was not in shape to be adopted.

The President: Are there any questions the members would like to put to the committee in order to bring up discussion?

Mr. Cartlidge: I move to amend the motion before the house by asking that the whole specification be read paragraph by paragraph, so that the members can comment on such paragraphs as they desire.

Mr. Osgood withdrew his motion and the motion by Mr. Cartlidge was adopted.

The secretary read paragraphs 1, 2, 3.

B. Douglas (D. R. T.): I would like to know why the 70 per cent was put in the clause of the specification. I have tested a good many natural sands, and never yet found one that I thought in any way suitable for making concrete that did not show a strength greater than 70 per cent, and it seems to me that 70 per cent is too low.

Mr. Humphrey: This specification was taken from the recommendation of the joint committee on concrete. I take it that the gentleman does not object to a test of the material, but merely to the percentage, to show that it was up to the standard of Ottawa sand. The sands that come from all parts of the country vary in wide ranges and to start off with a specification too high would be, perhaps, bad, and for the purpose of having people test the sand and give the same careful consideration that they give cement—and in most concretes the sand itself is of as much importance as the cement which binds it together—we believe it is desirable to have that percentage not too high. It is probable that in many sands that might be raised, but I do not believe any one is prepared to say where it should be, and I believe that 70 per cent, as a starting point, is conservative.

Mr. Osgood: I ask why it is necessary to make any reference to Ottawa sand? Why should we not specify the mechanical strength? We do not know anything about Ottawa sand unless we secure a sample of it, but we do know about the sands we get and what we can get from them. I do not believe there is any difference in ordinary good sands in the strength of the product. I cannot see any good reason why we should make any reference to Ottawa sand.

Mr. Humphrey: The only reason is that in the standard specification for Portland cement, standard Ottawa sand is called for, and it seems desirable to adhere to that sand as a measure of standard. It is true you may be able to get a figure for your particular locality, but to make a broad general specification you cannot express it in figures, and there is a decided variation, as shown by many tests, in the quality of sands apparently of the same character in different parts of the country, and the only way the real Ottawa sand can be determined is by physical test and not by visual inspection.

Mr. Osgood: Would it not be well to specify so many pounds to the square inch?

Mr. Humphrey: The object of this is to correlate it with the test of cement, and to fix an arbitrary standard would not apply to all parts, but if you use as a basis the percentage of what you get with the cement and Ottawa sand, you get a definite basis.

Mr. Osgood: It seems possible to take neat cement and make a test of that kind which would give information as to the cement. I do not like the idea of lugging in some special sand, of which we must procure samples to test our cement.

Mr. Humphrey: I think perhaps the gentleman is somewhat confused in his ideas concerning the matter. The idea of this test is to get the strength from the mortar box, and the strength from the sand depends on the gradation, size of particles, surface coating, and a number of other elements, and the only way in which you can tell if the sand is suitable is to make mortar and see what strength you get, compared with your laboratory test of the same screenings of Ottawa sand.

Mr. Osgood: I still cannot see why we cannot be satisfied with our local sands if we know they will produce the results.

Mr. Humphrey: I feel in the matter of concrete, which is one of the materials that is coming into greater and greater use in railroad construction, that it is high time that we began to study some of the other materials that enter into its makeup and specify more rigidly as to the qualities of the materials that enter into the composition of concrete, besides the cement. Standard Ottawa sand seems to be, after many years of research by the committees of the American Societies of Civil Engineers, and the committees of this association and others, to be a good standard, and this committee is simply endorsing that standard and simply saying, to measure the value of the sand you are going to use with the concrete, you should compare its strength with Ottawa sand concrete made out of the same cement and same consistency of sand. You have to use it in testing your cement, and we do not know of any other standard which has received such general approval.

The President: There will be no vote taken on the paragraphs, but the discussion is for the information of the committee.

Mr. Condron: Possibly Mr. Osgood failed to take account of the fact that paragraph 1 of the specifications reads: "Cement shall be Portland, and shall meet the requirements of the standard specifications. (See Manual.)" Referring to the Manual, page 110, under "standard sand," it says: "For the present the committee recommends natural sand from Ottawa, Ill.," etc. We have not attempted to revise this portion of these specifications, but this is all a part of the recommended practice in the Manual.

The secretary read paragraph 4.

Mr. Loweth: I can say, without fear of contradiction, that good, clean crushed stone with the dust in it and fine particles due to the crushing, makes an excellent quality of concrete, and I see no reason why we should make a specification that excludes the fine screenings.

Mr. Humphrey: Would you prefer to have the crusher run?

Mr. Loweth: Yes.

Mr. Humphrey: The idea of the specification was to separate the coarse aggregates and the fine aggregates. The fine aggregates to which you refer can be used under paragraph 2. There is no attempt to rule out the crusher screenings.

Mr. Loweth: Do you mean they shall be handled separately?

Mr. Humphrey: Not necessarily, but we think it preferable to separate the two.

Mr. Loweth: We think it not preferable to separate screenings from crushed stone, because when they are separated it is harder to get a uniform mixture than when the screenings are left with the stone. We prefer in summer to have the stone dusts which come from the crusher.

F. Lavis (P. T. & T.): I think the recommendation of the committee is the better one in this case, on account of the difficulty in determining the amount of fine material in a crusher stone. I have had considerable experience in that line and if you use run-of-crusher stone it is undoubtedly difficult to get proper proportions of fine and crushed stone.

O. P. Chamberlain (C. & I. W.): In regard to the use of stone screenings, in speaking of the recommendations of the committee, I think the committee's recommendations are now in proper form. The commercial stone as it is sold by most of the concerns that handle that commodity is screened at the crusher. Those screenings are a simple product, and mixing it with concrete, you can use it in place of sand. While I believe as Mr. Loweth has said, that crusher run produces a very good concrete, there should be some means of determining the amount of screenings you are using in a concrete, and you cannot do that unless you have the screenings separated from the larger stones of the aggregate before the mix is made. It seems to me that No. 2 in the specifications covers the screenings proposition and should stand as it is.

The secretary read paragraph 5.

Mr. Cartlidge: I would suggest that the whole of the last sentence under paragraph 5 be left out. The question is entirely covered in the first sentence. I think the committee must have had in mind that reinforced concrete is made invariably in sections. There is no reason why reinforced slabs cannot be made with 3-in. stones. I do not think we should be limited to 1 in. stone.

The secretary read paragraphs 6 and 7.

Mr. Cartlidge: There is another statement in paragraph 7 which is apt to cost us some money. It is pretty well understood, I think, that rust in small amounts on reinforcing rods is not objectionable and that the rust is absorbed by the concrete soon after the rods are placed in position. I think the section should be modified by making it read, "and be free from injurious or excessive rust, scale or coatings of any kind."

Mr. Humphrey: I think the clause covers that. It does not say it shall be free from rust, but free from rust which will tend to reduce or destroy the bond.

The secretary read paragraph 8.

Mr. Humphrey: The committee strikes out "Bessemer or the" in paragraph 8.

The secretary read paragraph 9.

Mr. Petersen: The table in paragraph 9 was changed at a meeting of the committee, and the 0.085 in the high carbon steel was changed to 0.088, and the 1,400,000 was changed to 1,200,000.

Mr. Cartlidge: I wish to protest against the exclusion of Bessemer steel from use in reinforced concrete. It is true that in small pieces, certain variations will occur in the character of the material, but they are very readily taken care of in the large factors of safety which are used in designing reinforced concrete. I do not believe Bessemer steel should be omitted.

J. P. Snow (B. & M.): I assumed the omission was made in paragraph 8, to make it conform to the table of physical requirements. Bessemer steel could not be produced as it is now made in this country to conform to the limits shown in this table.

J. E. Greiner (B. & O.): I do not think the committee has fully considered the question of the character of steel to be used in reinforced concrete. I do not see why the steel used in the reinforced concrete should not be just as good as steel used in any other class of construction. The specifications that this association has adopted for bridges and structures of that character, call for a steel which is suitable for reinforced concrete. It is a good steel, and is recognized as a proper quality. They propose here to use a high carbon steel, the only result of which will be the skinning down of the amount of material that is used for reinforcing concrete to a degree that it will be made of inferior material, and it is doubtful if it can be obtained in accordance with the specifications.

Mr. Cartlidge: I am not prepared to state what limits should be placed on the requirements for Bessemer steel, but I take exception to the statement that low carbon is best fitted for use in reinforced concrete. I believe the contrary is true, and a high carbon steel should be specified; and as to that I think the committee has taken the proper stand, and I believe they have already changed the limits in such manner as will provide for the safeguarding of the material. I think the Bessemer should be included.

Mr. Greiner: I do not think Bessemer should be kept in. It is not used except for an inferior grade of work. You can get open-hearth steel of the same quality as Bessemer steel. It is recognized that open-hearth is better than Bessemer—more uniform and more desirable all the way through. If there is a choice between two materials at practically the same price, and one much better than the other, I do not see why we should use the Bessemer, and I think it should be eliminated.

The secretary read paragraphs 10 and 11.

Mr. Petersen: The committee has changed the wording of paragraph 11 to read as follows: The ultimate strength of structural steel shall not vary more than 5,000 lbs., and the high carbon steel more than 8,000 lbs. from the desired ultimate.

The secretary read paragraph 12.

Mr. Condron: We may save time if I mention that the next few paragraphs are copied directly without change from the specifications that have already been adopted by this association for structural steel, and as they just involve these same figures, it may not be necessary to take them up in detail. The next paragraph that has any change in it, as I recall it, is paragraph 20, but that is the only succeeding paragraph in which there has been a change made in the structural steel.

Mr. Loweth: I would suggest that a little more study be made of this page and the next. We have two kinds of steel reinforcement. The simpler kind consists of rods and bars, and the more complicated, of shapes and plates, riveted or otherwise fastened to gether. I think the committee could simplify the requirements for reinforced steel so as to make the structural steel conform to the specifications already approved by the association, and then make a more comprehensive and clearer specification covering just plain bars and rods.

Mr. Condron: That was discussed in the committee, and I believe it was the sense of the committeee, although there was not a full attendance, that the high carbon steel specified here should be limited by a clause saying that the specification applies to rods and bars only. It was not intended to be applied to shapes or other material that might be punched and otherwise treated before it goes into the structure. I think the committee will make that change and perhaps clear up the matter Mr. Loweth has suggested.

The secretary read paragraphs 20 to 26.

C. S. Churchill (N. & W.): No. 26 says "a density proportion based on 1:9 shall be used." Is not that too positive?

Mr. Snow: I think what Mr. Churchill says in regard to 26 will also apply to 25. I think the committee should ameliorate that condition a bit.

The secretary read paragraphs 27-29.

Mr. Chamberlain: I see in paragraph 29 that reference is made to a batch mixer. I ask the chairman of the committee whether the matter of a continuous mixer was discussed in the committee. I presume it was. There are continuous mixers on the market that do satisfactory work at the present time, and I think it will be only a question of a year or two when they will be more satisfactory. That is the logical machine if it can be built to produce a proper mixture.

Mr. Humphrey: The committee is of the opinion that one of the most important things in the mixing of the concrete is to get the greatest strength out of the material, and certainly many forms of the continuous mixers on the market do not do that. One of the main essentials is that all ingredients in the mixture shall be kept continuously together for a period of not less than one minute, and the committee, therefore, indicated what they believed to be the best practice, and the surest means of getting the best practice, and they committed themselves to the type of batch mixer. If a continuous mixer is devised that will fulfill the requirements, that term "batch" could be stricken out.

Mr. Loweth: It seems to me we are not exercising care enough when we use the terms "best practice," "good practice," and "recommended practice." Now, the proposition is that these specifications shall be put in the Manual. The Manual is not a Manual of Good Practice, nor a Manual of Permissive Practice, it is not a Manual of True Practice, but it is a Manual of Recommended Practice, and I feel that it is a fair inference from that that it is not desirable to put anything in the Manual other than recommended practice.

Now, there may be several ways of making concrete. There may be a choice in these several ways, and I do not see why we should put our seal of approval on one method and condemn other methods, which in many cases will give just as good results, or in many cases will give fairly good results.

Mr. Humphrey: At the discussion of this question with the several joint committees, that point raised by Mr. Loweth was considered, and the word "batch" was omitted by the committee. The original specification called for a mixture which would produce a homogeneous concrete, not specifying the type of mixer. The committee, however, thought it best to insert "batch." I think the committee will now be willing to accept the suggestion to leave that word out.

The secretary read paragraphs 30-35.

Mr. Osgood: In paragraph 31 it says: "The materials shall be mixed wet enough to produce a concrete of such consistency as will flow into the forms and about the metal reinforcement." Was it the intention of the committee that it should be wet enough to flow without tamping? The concrete, unless it is mere slush, will not flow around the metal spaces unless it is tamped.

Mr. Humphrey: The committee's intention was that this flow should be helped by the aid of a slicing tool.

Fred Lavis (P. T. & T.): In regard to that same paragraph, it is sometimes difficult to carry out that provision entirely. For instance, in the construction of tunnels, the mixer is on the outside and the concrete must be carried a long distance to the point where it must be deposited, and it usually does separate to a certain extent. It seems to be better to allow it to do that than to make it dry so that it will not separate. That is overcome to a certain extent by a second mixing when it gets to a point where it is to be deposited.

Mr. McDonald: In the clause about depositing concrete under water, I think it would be well for the committee to emphasize the importance of guarding against laitance, not only at the point where the concrete is under water, but where it is deposited in forms. I recall instances where laitance has appeared in the filling columns and resulted in repairs to the building after the construction of it.

Mr. Osgood: I have an instance in mind where a pier for a double arch was spoiled by too much laitance, the work having been left at a critical period for a short time, and it was necessary to take down a considerable portion of the concrete.

Mr. Condron: Both those points are provided for in paragraph 50.

The secretary read paragraphs 36-40.

Mr. Snow: I suggest to the committee that they insert something as to the minimum distance for these imbedded stones, depending on the size of the pieces of the aggregate.

The secretary read paragraphs 41-47.

S. E. Coombs (N. Y. C.): There is a good deal of similarity between 36 and 47, except for the words "freezing weather" in 47.

The secretary read paragraphs 48-51.

Mr. Osgood: In paragraph 51, 50 ft. is given as the length and I think that is about right. We have usually found that a little less than 50 ft. could be obtained, and this was preferred. It also says: "To provide against unsightly cracks due to unequal settlement, a joint shall be made at sharp angles." That is the last sentence in the paragraph. It occurs to me it might be well to make some reference to the desirability of making a joint by means of triangular chips of wood, or otherwise, on each line where the two sections come together. We found it added very much to the appearance of the work, and that such cracks as occurred were confined to well defined lines, fixed by these triangular pieces of wood inserted in the forms.

Mr. McDonald: In connection with 51, I suggest the committee consider the advisability of expansion joints in the building.

Mr. Coombs: In paragraph 50, I suggest the committee outline more thoroughly what they mean by "thoroughly cleansed." That point was up for considerable discussion in the American Society of Civil Engineers, and the word "thoroughly" was understood differently by different people.

The secretary read paragraph 52.

W. H. Courtenay (L. & N.): I would suggest that an addition be made to the specification, in reference to dropping concrete from a great height, or shooting it down a chute from a great height. That is being frequently done.

The President: The committee will give due consideration to the points brought up.

Mr. McDonald: I suggest the committee request the members present to voice their objections now to any clause in the specifications which have not already been objected to, in order that the committee may have some basis on which to work the coming year.

The President: Or send it in writing, gentlemen, if you prefer.

W. F. Steffens (C. C. & O.): Was it the sense of the gentleman in the rear of the room that the high limit in reinforced rods be eliminated or continued?

Mr. Humphrey: There were two gentlemen discussing it, one in favor of eliminating the high carbon steel and the other in favor of retaining it.

Mr. Petersen: In addition to the report which has been submitted, we should like to have incorporated in the proceedings a progress report of the Joint Committee on Concrete and Reinforced Concrete; also the report on Concrete Trestles, shown in appendix D.

Mr. Humphrey: If I may be permitted to say a few words in connection with the Joint Committee report, I will state that the committee had voted to present this report as an information report. Through a misunderstanding the secretary of the association failed to incorporate it in Bulletin 108, and the reports of the Joint Committee which were distributed here were furnished in order to supply that omission.

This Joint Committee report was prepared and asked to be presented to the several societies and received as information, with the idea that it would be of value and interest to the several societies in the absence of an ability to reach a conclusive report. Of the thirty-three men composing the committee, twenty-seven voted for the report, four against and two not voting. On the basis of voting members there were fifteen votes for it and four against it, and the committee is now desirous that this be simply printed as information.

Mr. Schneider: Mr. Chairman, I would like to call attention to the fact that I am the chairman of the Joint Committee on Reinforced Concrete, and the chairman has a minority report signed by four members. That minority report has been suppressed.

Mr. Humphrey: I can say on behalf of the committee of this society that there were 3 members and 2 alternates and they simply presented the majority report of the committee as their report. The report to which the chairman referred was a report to the American Society of Civil Engineers. There was no minority report presented to the Joint Committee. The report presented here is a majority report to the Joint Committee and presented by the committee of this society, there being no minority report by any of the members.

Mr. Schneider: It is a misnomer. This report which is circulated around here is called a report of the Joint Committee.

Mr. Humphrey: As a matter of information, I would state that this committee was not aware there was any minority report presented to the Joint Committee.

Mr. Schneider: I call attention to the fact that the chairman has taken all the responsibility for that report.

ECONOMICS OF RAILWAY LOCATION.

The committee on Economics of Railway Location submitted a progress report. W. B. Storey, Jr., (Santa Fe), chairman of the committee, said:

As I understand it, the rules of the association require a report to be printed. No report having been printed there is practically nothing to be said before the association at this meeting. There has been no meeting of the committee during the year. The membership is scattered throughout the United States and it has not been possible to get them to meet and nothing has been accomplished which can be reported to this association.

ELECTRICITY.

The committee on Electricity made a progress report. S. E. Coombs (N. Y. C.) Chairman of the committee, said:

The committee on Electricity, which, with two exceptions, is the special advisory committee appointed by the Board of Direction to report upon the propriety of establishing a standing committee, held two meetings as an advisory committee and outlined a certain portion of the work. That committee has recently been appointed a standing committee, but has done no work since its appointment. The committee is at present getting together with the idea of beginning work.

CURING SLIDES AND WASHOUTS.

In Appendix C of the report on Roadway the committee gives a digest of interesting and instructive replies to a circular of inquiry sent to members of the association, which treat of various phases of the subject of curing slides and washouts. From these the following have been taken:

Richard M. Garrett (Resident Engineer, M., K. & T.):—The revetment put in by the Missouri, Kansas & Texas along the Missouri river, for shore protection, is built similar to those along the Missouri river, which have been made by the Missouri River Commission, and averages about 60 ft. in width. The first work put in by this company was during 1897, and extends from the east city limits of St. Charles down the river for 9,000 ft. A rock dike was first built out into the river, and a boom made of heavy timbers was anchored to lower side of dike, and laid parallel with it. From this boom the mat was started, having its full width at the beginning. The mat was first woven and sunk, and then the bank was graded by hydraulics to a slope of 2 to 1, and then paved from the top down.

In 1903, work was extended 3,000 ft. down the river, and was done in the same way as the first section, with the exception that the mat was anchored at the starting point with piles instead of the boom.

In 1906, revetment was again extended 7,200 ft. On this last section the bank was graded to a slope of 2½ to 1 in advance of weaving the mat, as considerable trouble had been experienced on former work, on account of material from the bank covering the mat, so that a connection between paving and mat could not be properly made.

Grading on this section was done with a small hoisting engine on a barge, as follows: A derrick was erected on barge, having a boom long enough to reach the top of the bank to be graded, a No. 3 wheeler scraper pan was pulled along this boom from the barge to the top of bank, by a mule on the bank, and was held in place by two men and filled, and then dragged down the bank by the hoisting engine. The beginning of mat was anchored to deadmen on top of bank about 200 ft. up stream, and weaving was begun about 100 ft. back on the old mat, so that full width of new mat was gotten where the unprotected bank commenced.

In 1908, 4,000 ft. of revetment was put in on the north side of the river just above Boonville bridge. At Kingsbury, there

is a siding on the west side of main line, and out of the south end of this track the spur was built to the river; this required a main track 6,500 ft. in length, and a spur track 900 ft. in length. Track was laid about 5 to 20 ft. from top of bank all along where revetment was to go in, so that rock could be unloaded and used with as little handling as possible. The bank was first graded to a slope of 2½ to 1 by teams; the mat was then woven and sunk, and the slope paved from bottom up. It is the description of this last section that will be given, as the only differences between this and other works are those mentioned.

The bank was about 18 ft. higher than what was taken as the average low water; the soil is mostly a very fine sand and very little gumbo; the bank was clear of timber and brush, but there were several large snags along where mat was to lay that were taken out by sawing, blowing-out and using teams and line.

Shovelers first dug along the top of the bank and shoveled down all the perpendicular and overhanging points, so as to make it safe for a mule to walk along close to the edge; then a two-mule team plowed two or three furrows as close to the edge of the bank as team could be gotten. The mules were then hitched to a "go-devil," constructed of two 2x10-in. plank 8 ft. long, fastened together at the front end and flared to about 4 ft. at the back end; it required one man to drive the mules and one man to weight the drag. This was then run along the back side of furrows, and the loose earth shoved toward the river. After the bank began to slope, two or three slips were put on, and the bank brought to the desired slope.

It will be seen that only about half of the material in slope is moved, as the excavation makes the fill and does not wash away, as it does when grading by hydraulics. It was found that with this material the filled portion was as solid as the natural surface. Grading was never carried further than 200 ft. in advance of weaving, as the barges from which the mat was being woven would protect the bank from the current for this distance. .

The mat was woven 60 ft. wide with a selvage edge on the out-stream side, and sunk parallel with the shore with the inner edge about 3 ft. above the average low water. The mat was strengthened with five double rows of ⅜-in. galvanized steel cable—7 strands to No. 11 wire—laid longitudinally one above and one below, and anchored with a double row of similar cable laid transversely every 15 ft. and fastened to deadmen, buried 3 ft. deep and located 15 ft. back from the upper edge of slope. At every intersection of the longitudinal with the transverse rows, the four cables are fastened together with a ⅝-in. "U" clip. The transverse rows are fastened to deadmen by wrapping one cable around the deadman twice and then fastening it to the other cable with two ⅜-in. "U" clips. The deadmen are pile butts about 3 ft. long, and the object in fastening the cable to them, as mentioned, is to allow the cables to slip when loaded, so that the same strain will be on both the under and upper cables. The willows were cut from bank of river about one mile above mat, and were hauled by wagons, hauling about 1.6 cords to the load. The road was bad at times, and it required a snap team to pull out of the mudholes, but most of the time the road was in good shape. It required 0.6 cord of brush to 100 sq. ft. of mat; average thickness of mat, about 18 in.

Weaving was started at a point at the upper end and gradually widened out to full width, anchors being placed for longitudinal cables in the top of the bank about 100 ft. above the upper end. The mat was woven with four small bags fastened together, so as to make the desired width. Fingers of skids were built on barges out of 3x12-in. plank, 24 ft. long, and spaced 5 ft. apart, extending from the water level on upstream side to an elevation of 3 ft. above floor of barge at a point about 3 ft. back from down stream side. Spools of cable were set under the down-stream ends of the fingers at the proper position for the under longitudinal cables, so that cable would unwind as the barge was let down stream. The barge was anchored at the shore end to the track, and at the upper end to the mat that had been woven. The mat was woven on the barge as high as the fingers would permit, and cable and clip men would pull the under cables through the mat by means of an iron hook about 2 ft. long, and the top longitudinal cables were run under these, and all were fastened together with a ⅝-in. clamp. The barge was then pulled from under the mat with a team, and anchor ropes slacked just enough so that about 3 ft. of mat would be left on fingers. Top longitudinal cables were cut off of reel on shore in lengths of about 100 ft., and spliced together with a square knot on mat, as the work proceeded.

The mat was sunk and held down with stone weighing from 30 to 50 lbs. An average of 1.5 cu. yds. of stone being used to the 100 sq. ft. of mat. Rock for sinking was unloaded from cars onto shoulder of slope and wheeled in wheelbarrows out onto the barge, anchored lengthwise across the mat, and dumped along the edge of barge. The mat was sunk from the shore side out, so that it would settle away from shore and the transverse cables would tighten up. Sinking was kept at least 100 ft. back from weaving barge to prevent pulling the mat off of barge. When the water was higher than the proper elevation for the shore side of mat, it was sparred out, so that in sinking it would settle to its proper position.

The rock for paving the slope was unloaded from cars onto slope and rolled down to the bottom, where paving was begun. Paving is 10 in. thick, and was paved from the bottom up, care being taken to fill all the cracks with small stone. At the upper edge of paving, spawls were piled so as to keep the surface water from washing under the paving and starting it to roll. As long as the water was low, a good connection was gotten between paving and mat, but there were parts of this work that were paved during high water, and the rock slid in afterward, making repairs necessary. The work done on the first section in 1897 is in very good shape today. The mat has rotted where it has been exposed to the air, but the paving is in good condition.

There have been some slides on the work done in 1906. At these places it was found that the rock was settling under the edge of the mat. These were places where the bank had washed after mat had been put in, and the mat does not lie up on the bank as it should.

Considerable trouble has been experienced on account of the eddy caused by the end of revetment. At Boonville bridge, the revetment ends at an old rock dike, and no difficulty is expected at that point but at all of the other places it has given trouble. At the end of the work done in 1906 it is probably more noticeable. The revetment at this place was ended at a place where the bank extended out into the river 400 or 500 ft., and now the bank is 100 ft. further in than the revetment, and the revetment has been repaired twice on account of the river washing behind the end, and allowing the rock to fall in.

The cost of the Boonville revetment is as follows: Cost per lin. ft. for 60-ft. mat; banks 18 ft. above low water; laborers paid $1.50 per day; foremen $4.00, and teams, $3.50. This does not include interest on investment or make allowances for rainy days and moving, but is the actual cost. The contractors' profit is included in the track work only:

Grading bank, per lin. ft.			.13
Weaving mat			.410
Sinking mat			.110
Paving slope			.230
Willows, including cutting, hauling and unloading, and price paid landowner			.340
Rock, at 0.75, delivered on site (2.3 cu. yds. to the lin. ft.)			1.730
Unloading rock			.120
Spotting cars with teams			.004
Hauling deadmen and cable			.018
Taking out snags			.030
Cable and Clips:			
1260—⅝-in. clips @ .06	75.60		
746—⅜-in. clips @ .035	26.16		
107150—⅜-in. cable @ 1.00	1071.50	1173.26	.300
Deadmen, 270 @ 50 = $135.00			.035
Track, 7500 lin. ft.			
Labor, grading, including contractors' profit	1581.90		
Labor, laying	1493.20		
Taking up	1000.00		
	4075.10		
Bridge across draw	460.00		
	4535.10	1.140	
Grading spur to quarry, $393.50			.074
Total cost per lin. ft.			$4.67

W. S. Kinnear (Assistant General Manager, Michigan Central): The writer has had quite a little experience with embankment slides, under various conditions, and recalls a sidehill embankment which gave us endless trouble from the first heavy rainfall after its construction until slide was finally checked, which will be explained hereafter. As mentioned, the embankment was on a sidehill, and initial steps to remedy the trouble consisted in hauling material by train and filling as rapidly as bank would go out below. It was found after a short time this would be practically an endless performance,

and measures were taken to ascertain the cause of the slide. A careful examination of the slope on the upper side disclosed a sloping waterbearing stratum of clay, some 8 or 10 ft. below the actual surface of the sidehill. For a considerable time after each heavy rainfall the top of this waterbearing clay would be thoroughly saturated, and it was found, in case of any disturbance below, the weight of the embankment would produce immediate slipping or sliding on the smooth clay. It was thought best to intercept the water from above and let the surface of clay, carrying the embankment below, dry out. This was done by means of a sheet piling ditch, about 3 ft. wide, some 15 or 20 ft. above the embankment. The sheet piling was driven a sufficient distance in the clay to secure firm footing and to prevent distortion. The material overlying the clay was excavated within the limits of the sheet piling, thus forming a ditch, which was carried to a waterway through the embankment to an outlet below. No further trouble was experienced, and the embankment held. It might be mentioned in this connection that a short time prior to the construction of the sheet piling ditch on the upper side one or two rows of piles were driven near the lower slope of the embankment, hoping in this manner to form some resistance to further slipping. The piles did absolutely no good, and were carried down and out of position by the slipping bank in a very short time. The writer thinks it is of the utmost importance, in case of either embankment or excavation slides, to immediately ascertain the cause, and thus save a great many false moves, which, at best, are very expensive.

The writer has also had trouble a great many times from old embankments, and has in mind one or two cases where high banks, some 20 or 30 years old, gave considerable trouble after periods of ordinary rainfall, due to conditions which we could not discover. We found the best treatment under such circumstances was to build perpendicular blind drains down the slopes, connecting with a similar blind drain parallel to the foot of the embankment. These drains were placed from 50 to 100 ft. apart, as conditions seemed to demand, and consisted of an excavated trench some 3 or 4 ft. deep, filled with one-man stones. These were carried entirely down the slope and brought up against a similar trench filled with stone carried along the foot of the slope throughout the length of the slide. We have not found one single instance where this method was not effective in stopping trouble.

It has been the writer's experience that slides in old embankments were likely to occur after the construction of a second-track roadbed. This was undoubtedly due to an interruption of the drainage and pressure of the new bank upon the old. Our method of treatment in such cases was similar to that described immediately above.

The writer has found from experience that landslides are very difficult to contend with, and in the majority of cases about the only remedy which can be applied is to keep the track as near grade as possible and wait for a new and permanent condition of the slope to become established. A study of the possibility of diverting certain surface water is always advisable under such conditions, and, in some cases, may prove of benefit, although we have always found, where a mountain side or steep sidehill is disturbed by the construction of a line of railroad, trouble will undoubtedly be experienced, which it will take years to overcome. The writer is not a believer in driving piles either in embankments or excavation to hold sliding masses.

W. A. McGonagle, First Vice-President of the Duluth, Missabe & Northern, describes two separate cases of slides that he took care of when Assistant Chief Engineer of the Duluth & Iron Range Railroad.

(1) An excavation was made for a grade reduction in a cut where the material was red clay mixed with quicksand. The depth of the cut, when finally completed, was approximately 35 ft. Considerable difficulty was experienced with slides, particularly on the up-stream or drainage side of the cut. Large cracks appeared in the material, these cracks being almost in a vertical plane. The slides were removed by the steam shovel, but the trouble did not cease until a row of cedar piles, placed 3 ft. apart, center to center, and reinforced with wallings of old bridge timber, securely bolted to the piles, was placed in position. The loose material behind this row of piles was then properly sloped. The surface was covered with manure and seeded with clover. This construction has been giving excellent service for more than ten years and no trouble has since been experienced from further slides.

(2) The approaches to the ore docks at Two Harbors consist of timber trestles supported on piles. The material into which these piles were driven was red clay mixed with quicksand, very similar to the material indicated in the preceding paragraph. The material was sloped in an angle of 2 horizontal to 1 vertical. Slides and cracks similar to those described above were experienced and in one case serious trouble resulted in pushing the trestle out of perpendicular. All kinds of experiments with drains and cross drains and with seeding the slopes were tried, none of them being successful. The slope was then changed to an angle of 4 horizontal to 1 vertical. This work was thoroughly done. The surface was then covered with manure and seeded with clover and no further trouble has been experienced during the fifteen years since the slopes were flattened. The height of the embankment at this point was approximately 60 ft.

R. Budd (Chief Engineer, Panama Railroad): The slides which we have encountered on the Isthmus are due principally to two causes: First, the inclined surface of the underlying strata of rock, and second, the unusual amount of rainfall. While it is necessary to study the conditions at each particular slide in order to arrive at treatment which it requires, there are some general conditions which apply more or less in every case. Among these, the writer would consider the prompt and effective removal of water, in order to prevent it reaching the impervious stratum of rock and flowing along it, thereby causing the overlying material to slip. The writer believes that it is an economy to establish such drainage, even at very great cost. We have used sluice boxes around the brow of a hill far enough back of the slope to be safe, and have also used V ditches lined with concrete, and make it a practice always in finishing cuts where sliding material is indicated to hand-dress the face, leaving the surface smooth to encourage the water to run away readily without giving it opportunity to soak into the side of the cut, as would occur if it was left rough.

In making large fills against a steep hill, where the additional weight of the embankment caused sliding, we have effectually prevented slides and stopped them by making a fill at a lower elevation and at a distance at one side about equivalent to 2-to-1 or 3-to-1 slope line, so that the filling at the toe of the proposed embankment would act as a balance to hold the side hill in equilibrium. Piles or retaining walls built of concrete or masonry placed at the toe of the slope act in the same way, but for preventing slides when making embankments of over 50 ft. in height, piles have not proven effective here, either because they do not get sufficient penetration in stable material, or, if they do, the force of the slide is sufficient to break the pile.

We have done very little in the way of building retaining walls, principally because on the Isthmus there is an abundance of excellent material for filling, and it has been cheaper to weight down the toe of the slope with excavated material from the Isthmian canal, which does not represent any cost except the handling.

In swamps the writer has found sinkholes that could be held in shape for operation by placing in them nothing but very light material, such as sawdust, barrel staves, cinders, machine crates, and the like, but in such cases it has required constant filling to keep the track up to grade, and it is the writer's opinion, based on borings which we have made, that such sinkholes are caused by a very soft material extending to a great depth and extending for considerable width in each direction, so that the entire mass may be likened to a large body of jelly, which affords no resistance to pressure in any one direction. In handling such a place, the writer would recommend a thorough investigation of the sub-strata with diamond core drills, and if this non-supporting material does not extend to too great a depth, he would recommend filling with heavy material, remedying the trouble permanently, but if the depth is more than 50 ft., he would consider it a very hazardous undertaking to attempt to fill it and try to keep the road open for traffic at the same time. If practicable, the writer would build a temporary run-around track to carry traffic and use the permanent line only for dumping material.

W. C. Curd (Assistant Engineer, Missouri Pacific): The writer would call attention to a new form of riprapping which is being used in the South to some extent. This is known as anchor riprap. It consists of mats built of poles and brush wired together in the form of cells or pigeonholes. Each cell is about 8 or 10 ft. square and 6 ft. deep. The bottom is made as tight as possible with brush, but the walls and covers are loose to permit water to circulate and to deposit sediment in the cells. These mats are floated to place and are anchored at the desired point at low-water height. During flood conditions sediment is gradually deposited in these cells and the entire mattress soon sinks to a permanent rest. This method is claimed to be a splendid success.

MEETING OF THE RAILWAY SIGNAL ASSOCIATION.

The annual meeting of the Railway Signal Association was held on Monday, March 16. The principal feature of the meeting was the debate at the afternoon session on the report of Committee No. 1 on "Signaling Practice" for the purpose of coming to a better understanding of varying practice.

The following question was submitted: "Resolved that the Scheme of Railway Signaling Presented at the Washington Meeting is the Best Scheme of Signaling Devised to Date."

The speakers for the affirmative were Mr. W. H. Elliott, of the New York Central & Hudson River, and Mr. C. C. Anthony, of the Pennsylvania Railroad; for the negative, Mr. L. R. Clausen, of the Chicago, Milwaukee & St. Paul, and Mr. T. S. Stevens, of the Atchison, Topeka & Santa Fe.

A large chart was used to display the system of indications passed upon by the association last fall, called Scheme No. 1. On the same chart was also shown comparatively Scheme No. 2, which the negative side argued was an improvement. In other words the negative sides argued in favor of speed signaling as opposed to the route and speed system and of the type of home and distant automatic block signals, using a second arm to indicate the position of the next signal ahead.

Mr. Elliott, for the affirmative, contended that Scheme No. 1 calls for two very important changes from present practice; the first, that the indication of the semaphore arm shall be given in the upper quadrant, and the second, that the required indication shall be given by one arm and by one light instead of by a combination of one arm and two lights.

Mr. Elliott made the following points:

That the giving of the indication by one arm and one light is better than by two or more lights and arms in combination.

That the giving of the cautionary indication by a distinctive position of the arm is the most consistant and the safest practice.

That the change from the present to the uniform system may be made without confusion and danger.

That it will be comparatively inexpensive to change from the present to the uniform system.

Mr. Stevens, for the negative, dwelt principally on night indications and was in favor of using two signals on the pole, a top arm to inform the engineer as to what he should do immediately, and one below to indicate the position of the next signal.

Mr. Anthony, for the affirmative, said that Scheme No. 1 does not require the engineman to remember where the signal is located. The top arm, he said, is to govern high speed, main line movements, the lower arm is to indicate reduced speed movements, as where one track diverges from another. He thought that in considering a signal system of uniform use, the committee ought to consider the habits of enginemen and follow established principles as far as possible. He made several specific claims to show that Scheme No. 1 was far less radical than Scheme No. 2.

Mr. Clausen, who closed for the negative, held that Scheme No. 1 contained arbitrary indications which required study even on the part of a signal engineer, to say nothing of an engineman running at high speed. He was of the opinion that the scheme differed too much from standard code practice.

In the general debate which followed, C. E. Denny, signal engineer of the Lake Shore & Michigan Southern, said that in the near future his road proposes to change from left-hand to right-hand running. When the change is made, he said, a new system of signaling will be introduced, and it has been decided to adopt Scheme No. 1, or that recommended by the committee.

The majority of those who participated in the debate seemed to be of the opinion that Scheme No. 1 was the easier of application to present practice.

THE ROAD AND TRACK SUPPLY ASSOCIATION AT THE CONVENTION.

The exhibit of railway appliances made by members of the Road and Track Supply Association on the occasion of the annual convention of the American Railway Engineering and Maintenance of Way Association in Chicago was, in every respect, the most interesting and important exhibition ever given by this association; in fact, it was one of the largest, most varied, most interesting and most important exhibitions of appliances used in the construction, maintenance and operation of railways ever given anywhere, or at any time.

In previous years the Road and Track Supply Association used about 4,300 sq. ft. of floor space in the Auditorium Hotel for its exhibits. This year it secured the Coliseum and used all of the main floor and part of the Annex; in all, 54,897 sq. ft., of which 38,655 sq. ft. were devoted to exhibits, and 16,244 sq. ft. to aisles. There were about 140 exhibitors. The Coliseum was well decorated and presented a very attractive appearance. The crowds attending the exhibition were large.

The Road and Track Supply Association furnished automobiles for the convenience of its guests in going between the Auditorium hotel and the Coliseum. Band concerts were given at the Coliseum each afternoon and evening.

On Tuesday, March 16, the Road and Track Supply Association held its annual meeting at the Coliseum and elected the following officers for the ensuing year:

President—W. F. Schleiter, of Dilworth, Porter & Co., Ltd., Pittsburg, Pa.

Vice-President—T. W. Snow, Otto Gas Engine Works, Chicago.

Secretary and Treasurer—John N. Reynolds, Western Manager, Railroad Age Gazette, 160 Harrison street, Chicago.

Executive Committee—John McKinnon, Kalamazoo Railway Supply Co., Kalamazoo, Mich.; George Stanton, Cleveland Frog & Crossing Co., Cleveland, Ohio; Robert E. Belknap, Pennsylvania Steel Co., and Maryland Steel Co., Chicago; John W. Duntley, president Duntley Manufacturing Co., Chicago; A. P. Van Schaick, president W. K. Kenly Co., Chicago; Azel Ames, Kerite Insulated Wire & Cable Co., New York, N. Y.

The following is a list of exhibitors, together with an enumeration of the articles and devices that they have on display, and the names of their representatives:

Adams & Westlake Co., Chicago.—Signal lamps, lanterns, railway specialties. Represented by W. H. Baldwin, G. L. Walters, H. G. Turney, A. S. Anderson, C. B. Carson and and W. J. Piersen.

Alamo Manufacturing Co., Hillsdale, Mich.—Gasoline engines for railway service, pumping outfits, electric outfits and storage batteries. Represented by L. C. Thompson.

Allith Manufacturing Co., Chicago.—Allith parallel door and fire door equipment. Represented by W. D. Jameson and F. E. Sladden.

American Asphaltum & Rubber Co., Chicago.—Model tunnels, reservoirs, floors, platforms and bridges showing waterproofing process, roofings and railway paints. Represented by Harry N. Fox, advertising manager; N. S. Kidder, Harry E. Fox, W. R. Trasher and J. Y. Hill.

American Concrete Co., Chicago.—Full size section of reinforced concrete culvert pipe, model of a reinforced concrete pile trestle and photographs of reinforced concrete slabs and girders. Represented by T. E. Kelly and A. M. Anderson.

American Guard Rail Fastener Co., Philadelphia, Pa.—Anchor guard rail clamp, plate guard rail fastener, reinforced malleable iron brace, and Vaughan automatic rail anchor. Represented by D. F. Vaughan.

American Hoist & Derrick Co., St. Paul, Minn.—Moving pictures showing the American railway ditcher in operation. Represented by W. O. Washburn, F. J. Johnson and W. L. Manson.

American Locomotive Co. and Atlantic Equipment Co., New York.—Photographs and pamphlets, steam shovels and locomotives. Represented by John H. Wynne, Ottis Parsons and A. M. Sheffer.

American Rail Joint Co., Toronto, Canada.—Reinforced angle bar. Represented by T. D. Beddoe.

American Rolling Mill Co., Middletown, Ohio.—American ingot iron corrugated metal culverts and American ingot iron corrugated roofing and siding. Represented by G. H. Charls.

American Specialty Co., Chicago.—Collis flat and flat twisted high speed drills and Use-em-up drill sockets. Represented by J. L. Walker and H. L. Mills.

American Steel & Wire Co., Chicago.—Right of way fences, rail bonds, triangle mesh concrete reinforcements. Represented by R. S. Knight, C. D. Sturdevant, B. H. Ryder, R. Stanley Green and B. B. Ayres.

American Valve & Meter Co., Cincinnati, Ohio.—Water service supplies, embracing Poage automatic water column, tank fixtures, float valves, Fenner drop spout; track devices, showing Anderson's Economy switch stands for main line and yard purposes. Represented by N. Paul Fenner, Jr., J. T. McLarry, F. C. Anderson and E. P. Smith.

American Well Works, Chicago.—Pumping machinery, well

drilling machinery, steam engines, gasoline engines and air compressors. Represented by Geo. W. Igo, C. O. McLean and Harry Spiller.

Asphalt Ready Roofing Co., New York.—Arrow and Protection brands of roofing and model showing how Protection roofing can be laid on reinforced concrete. Represented by A. H. Allen, C. A. Sparrowhawk and Barney Blackwell.

Baird Railway Steel Tie Co., Topeka, Kan.—Railway steel ties, etc. Represented by Archie M. Baird, L. T. Yount, W. H. Holmes and E. D. Coon.

Barrett Manufacturing Co., New York.—Bridge waterproofing with bituminous binder protection, floor construction for use where a wooden floor is required directly on the ground without air space beneath and gravel roofing. Represented by W. S. Babcock, L. P. Sibley, H. B. Nichols and C. T. Bilyea.

Bausch & Lomb Optical Co., Rochester, N. Y.—Surveying instruments of new and improved types. Represented by H. D. Skelton.

Beaver Dam Malleable Iron Co., Beaver Dam, Wis.—Tie plates and rail braces. Represented by J. V. Cowling, James Small, E. A. Hawks, W. L. Douglass and D. P. Lamoreux.

J. A. & W. Bird & Co., Chicago.—Zolium flexible tile roofing, Paradux canvas roofing, Rex Flintkote roofing and Ripolin imported enamel paint. Represented by F. A. Moreland, F. A. Dale, Paul L. Griffiths, Howard Schofield and H. D. Johnson.

Blake Signal & Manufacturing Co., Boston, Mass.—Dispatcher's office desk for selective signalling, steam railway type semaphore signals and electric railway type semaphore signals. Represented by C. C. Blake, E. J. Burke and G. H. McFee.

Blocki Brennan Refining Co., Chicago.—Carboxide elastic metal preserver and its bi-products. Represented by W. F. Brennan, F. W. Blocki and R. P. Brennan.

Bryant Manufacturing Co., Sales Agents for the McClintock Manufacturing Co., St. Paul, Minn., also Sandwich Electric Co., Sandwich, Ill., Chicago.—Railway signals, appliances and supplies, train dispatchers' telegraph system. Represented by George Bryant, R. I. Baird, Edward McClintock, W. M. McClintock, M. A. Hovey, E. C. Hennis, E. Parsons, H. O. Rugh and C. S. Rhoades.

Bryant Zinc Co., Chicago.—Signal supplies, battery supplies, fibre conduit storage batteries, crossing bells, battery wells. Represented by E. M. Deems, M. R. Briney, R. N. Baker, H. J. Horey, S. Bryant, A. F. Klink, Rufus N. Chamberlain, R. Parmelee and F. N. Herbst.

Buda Foundry & Manufacturing Co., Chicago.—Railroad motor and velocipede cars, also parts of same; track drills, portable tool grinders, ball and cone bearing and ratchet jacks, switch stands, car replacers, adjustable switch rods and electric crossing gates. Represented by H. K. Gilbert, Wm. P. Hunt, Jr., L. M. Viles, W. S. Weston, C. H. DeLano, J. L. Artmier, A. R. Dyer, W. C. Dyer, H. S. Evans, J. J. Gard, L. Hamill, J. T. Harahan, Jr., J. M. Lovett, W. B. Paulson, G. B. Shaw and H. L. Shepard.

Buffalo Railway Wrench Co., Buffalo, N. Y.—Large ratchet wrenches for railway and bridge work. Represented by Lucian C. Jackson and George C. MacGregor.

D. J. Burlingame, First National Bank Bldg., Chicago.—Burlin vertical filing cabinet and office equipments of all kinds. Represented by D. J. Burlingame.

Call Automatic Switch Co., Chicago.—Automatic railway switch. Represented by O. C. White, I. A. Call and George W. Call.

Carnegie Steel Co., Pittsburg, Pa.—Section of standard track with Carnegie ties, insulated and non-insulated; Duquesne splice bars, rail sections, steel tie sections, portable track, steel wheels, light electric traction service wheels, Friestedt interlocking channel bar piling, U. S. steel sheet piling, freight car wheels on axle showing condition after service of 76,698 miles without turning, and slack barrel cooperage illustrating steel hoops on spike and bolt kegs. Represented by N. M. Hench, W. A. Bostwick, C. G. Bacon, W. G. Totten, C. B. Friday, P. W. O'Brien and J. B. Arnold.

Central Foundry Co., New York.—Universal cast iron pipe. Represented by Julian L. Yale & Co., Chicago, including Charles L. Sullivan, H. L. Winslow, Frank Miller and F. J. Cooledge.

Century Manufacturing Co., Columbus, Ohio.—Adjustable steel drawing tables, table covers, adjustable instrument trays and parallel rule attachments. Represented by H. J. Sharp and R. G. Thomas.

Cleveland Frog & Crossing Co., Cleveland, Ohio.—Two types of manganese crossings, manganese frogs, switches, switch stands, Lucas guard rail clamps and Prentice anti-rail creepers. Represented by G. C. Lucas and George Stanton.

J. B. Clow & Sons, Chicago.—Plumbing apparatus, steam, gas and water supplies. Represented by S. McKeeby, Y. A. Adams, W. T. Brace and T. J. Hester.

Conley Frog & Switch Co., Memphis, Tenn.—Conley patent frog. Represented by John E. Conley.

Continuous Rail & Safety Switch Co., St. Louis, Mo.—Continuous rail device eliminating present frog and guard rail. Represented by W. G. Brown and H. F. Roach.

Cook's Standard Tool Co., Kalamazoo, Mich.—Climax track drill, Magic high speed flat bits, Standard track tool grinder and Cook's combination chuck. Represented by Eugene Cook.

C. H. Cornell, Valentine, Neb.—Model of lock spike. Represented by C. H. Cornell.

Dake American Steam Turbine Co., Grand Rapids, Mich.—Locomotive headlight turbine. Represented by Charles W. Dake and R. J. Peters.

Delta Electric & Manufacturing Co., Chicago.—Represented by the Bryant Zinc Co., Chicago, and Harold N. Keifer.

Detroit Graphite Co., Detroit, Mich.—Paints for all kinds of railway stations, power houses, structural steel water tanks, bridges, roofs, etc. Represented by B. O'F. Randolph, T. R. Wyles and L. D. Mitchell.

Paul Dickinson, Inc., Chicago.—Dickinson cast iron and fire proofed wood smoke jacks, cast iron ventilators and chimneys. Represented by J. A. Meaden, A. J. Filkins, E. W. Hodgkins and F. C. Webb.

Eugene Dietzgen Co., Chicago.—Complete line of engineering instruments. Represented by W. E. Cook, C. S. Breckenridge, W. O. Phillips and O. C. Haier.

Dilworth, Porter & Co., Ltd., Pittsburgh, Pa.—Tie plates and spikes. Represented by W. F. Schleiter and C. Stein.

Joseph Dixon Crucible Co., Jersey City, N. J.—Dixon's silica-graphite paint for railway bridges, signal pipes and steel cars; Ticonderoga graphite ore and photographs of railway bridges and other structures; crucibles, air brake and triple valve grease. Represented by DeWitt C. Smith and W. B. Worley.

Dodge Manufacturing Co., Mishawaka, Ind.—Large water softener in operation and power transmission machinery. Represented by E. Eldon.

Dressel Railway Lamp Works, New York.—Switch lamps, semaphore lamps, crossing gate and station lamps. Represented by F. W. Dressel, Edward W. Hodgkins and F. W. Edmunds.

G. Drouvé Co., Bridgeport, Conn.—Anti-Pluvius puttyless skylight and the Lovell window operator. Represented by William V. Dee, George J. Adam and R. S. Adam.

Duntley Manufacturing Co., Chicago.—Rockford motor section and inspection car. Represented by C. E. Walker.

Duplex Metal Co., Chicago.—Copper clad wire. Represented by J. F. Kimber and Frank Chambers.

Eastern Granite Roofing Co., New York.—Ready roofing, granite roofing, smooth-surfaced roofing. Represented by H. Henning, A. E. Roever and P. G. Kennett.

Economy Separable Switch Point Co., Louisville, Ky.—Mitchell and Palmer types separable switch points, Economy separable claw bars. Represented by W. M. Mitchell, W. M. Mitchell, Jr., and O. Metcalf, Jr.

Edison Manufacturing Co., Orange, N. J.—Edison and "BSCO" primary batteries for signal work. Represented by C. H. Wilson, E. E. Hudson and F. J. Lepreau.

Electric Storage Battery Co., Philadelphia, Pa.—Chloride-Tudor-Exide storage batteries for car lighting and signal service. Represented by G. H. Atkins.

Eyeless Tool Co., Newark, N. J.—Eyeless picks and railway track tools. Represented by George Ackerman.

Fairbanks, Morse & Co., Chicago.—Motor velocipedes, track tools, section motor cars, pumping engines and pumps, electric units and a model track scale. Represented by A. A. Taylor, R. E. Derby, R. A. Paterson, J. A. Steele, H. D. Smith, C. W. Kelley, R. H. Lincoln, C. T. Fugitt, C. D. Walworth, R. E. Edler and W. R. Krausch.

Frank M. Foster, 515 West First avenue, Columbus, Ohio.—Foster interlocking switch stand, modern right angle drive and photographs of the Foster sod liner and grader. Represented by Frank M. Foster and George E. Kalb.

Franklin Manufacturing Co., Franklin, Pa.—Reinforced corrugated asbestos roofing or siding, asbestos Century shingles, asbestos building lumber, a miniature asbestos lumber smoke jack and samples of all kinds of asbestos pipe covering. Represented by R. J. Evans, E. R. Rayburn, L. B. Melville and C. H. Fresher.

General Railway Signal Co., Rochester, N. Y.—Electric interlocking devices, manual interlocking devices, block signals, relays and indicators and relay boxes. Represented by W. W. Salmon, G. D. Morgan, M. Wuerpel, L. Thomas, W. G. Hovey, H. M. Sperry, M. R. Briney, W. K. Howe, F. L. Dodgson, C. O. Poor, G. H. Macdonough, J. L. Langdon, F. W. Moffett and W. R. Young.

Gifford-Wood Co., Hudson, N. Y.—Models of machinery for elevating, conveying and lowering natural and manufactured ice, ice tools. Represented by W. T. Wood, N. H. Williams and G. B. Vernier.

Goheen Manufacturing Co., Canton, Ohio.—Carbonizing coating for iron and steel. Represented by A. W. Price and J. W. Goodrich.

Henry Graff, Chicago.—Mail catcher. Represented by Henry Graff and Gus E. Nyquest.

Peter Gray & Sons, Boston, Mass.—Lamps and lanterns and Gray chimneyless burner. Represented by George M. Gray and J. M. Brown.

Grip Nut Co., Chicago.—Grip nuts. Represented by E. R. Hibbard and F. E. Miner.

Hall Signal Co., New York.—Automatic signaling devices. Represented by W. J. Gillingham, Jr.

Hart Steel Co., Elyria, Ohio.—Rolled steel, reinforced shoulder tie plates of various types. Represented by W. S. Miller, W. T. Bentz, G. S. Wood, H. W. Davis and A. W. De Rocher.

Hawley Down Draft Furnace Co., Chicago.—The Hawley (Schwartz) furnace using oil or gas and the Reyelbec coke furnace. Represented by Cliff Bleyer, Col. C. E. Bleyer and F. O. Bartlett.

Hayes Track Appliance Co., Geneva, N. Y.—Models of Hayes derails with operating and target stands. Represented by P. W. Moore, W. Harding Davis, Wellington B. Lee, Arthur Gemunder and S. W. Hayes.

Hercules Continuous Rail Devices, Chicago Heights, Ill.—Continuous rail, crossings, frogs, switch points and derails. Represented by J. W. Street and S. P. White.

James O. Heyworth, Harvester building, Chicago.—A 2½-yd. bucket used with the Heyworth-Newman excavator with photographs and literature. Represented by H. G. Halleck.

Hydrex Felt & Engineering Co., New York.—Photographs of work done throughout the United States and a model of a bridge waterproofed with the Hydrex method. Represented by E. W. DeKnight and Theodore A. Schaffer.

Interlocking Nut & Bolt Co., Pittsburg, Pa.—The Clark nut lock and bolts for railway use. Represented by R. A. Clark.

Jeffrey Manufacturing Co., Columbus, Ohio.—The Jeffrey "Lock-Jaw" track and car wrench, Jeffrey improved spike bar and other railroad specialties; also standard Jeffrey chains for elevating and conveying equipment. Represented by J. A. Werner, E. D. Clapp, G. R. Kittle and J. W. Jeffrey.

H. W. Johns-Manville Co., New York.—Asbestos and magnesia products, fuses and electrical devices, roofings, smoke jacks, packings and rubber goods of all kinds. Represented by F. W. Gilmore, P. C. Jacobs, J. E. Meek and J. C. Younglove.

O. F. Jordan Co., Chicago.—The Jordan battleship-spreader, center plow, flanger, scraper, bank builder and snow plow. Represented by O. F. Jordan and M. J. Woodhull.

Joyce-Cridland Co., Dayton, Ohio.—Hydraulic car and track jacks. Represented by F. I. Joyce, George Llewellyn and N. Kohl.

Kalamazoo Railway Supply Co., Kalamazoo, Mich.—Hand and push cars, improved reinforced pressed steel wheels, velocipedes, track drilling machines, ratchet and friction track jacks, rail benders, Perfect steel surface cattle guards, track tools, track gauges, track levels, etc. Represented by John McKinnon, C. A. Wallace, W. I. Clock, C. L. Cushman and George W. Mingus.

W. K. Kenly Co., Chicago.—Latimer switch point lock, Security anchor tie plate, Universal pipe line carrier base, Pioneer rail anchor, velocipede cars, Moore track drill and Kalamazoo jacks. Represented by A. P. Van Schaick, W. J. Fauth, P. O. Wadsworth and J. T. Wells.

Kennicott Water Softener Co., Chicago Heights, Ill.—Water softener, photographs of railway installations and a machine showing enlarged lantern slide views of typical railway installations. Represented by Cass L. Kennicott, Edwin J. Flemming, Frank S. Dunham, R. S. Ellis and C. R. McKee.

Edwin R. Kent & Co., Chicago.—Rigid Stag manganese steel frog, special Stag manganese steel frog, guarded Stag manganese steel frog, Stag manganese rolled rail. Represented by Edwin R. Kent, J. H. Kent, J. T. Stafford and Geo. H. Brown.

Kerite Insulated Wire & Cable Co., New York.—Kerite insulated wires and cables. Represented by R. D. Brixey and B. L. Winchell, Jr.

Keuffel & Esser Co., New York.—Drawing materials, surveying instruments, masonry tools. Represented by Rudolf Link and O. S. Rhea.

Lackawanna Steel Co., New York.—Rails, rail joints, structural and bridge material, reinforced concrete bars, steel sheet piling and track supplies. Represented by C. R. Robinson, G. A. Hager, F. E. Abbott and D. H. Van Pelt.

Light Inspection Car Co., Hagerstown, Ind.—Light inspection cars. Represented by Will Immel.

Lufkin Rule Co., Saginaw, Mich.—Measuring tapes and rules of all kinds. Represented by Theodore Huss, S. B. McGee and Walter M. Sanford.

Manganese Steel Rail Co. and Ramapo Iron Works, Hillburn, N. Y.—Manganese steel pointed switch, switch stands, frogs, guard rail clamps, manganese steel rails, bars, springs, shovel, plate and photographs. Represented by Fred W. Snow, F. C. Stowell, Arthur Gemunder, W. C. Kidd and James B. Strong.

Maryland Railway & Electric Supply Co., Baltimore, Md.—"Spike Strut" rail fasteners, track appliances. Represented by Charles Elliott.

C. F. Massey Co., Chicago.—Massey battery wells, steel concrete composition battery chutes and pipe carrier foundation. Represened by C. F. Massey and Fred A. Lundahl.

W. N. Matthews & Brother, St. Louis, Mo.—Matthews holdfast lamp guards, guy anchors, cable clamps and the Lima jack box and plug. Represented by Claude L. Matthews, W. N. Matthews and Victor L. Crawford.

McDowell, Stocker & Co., Chicago.—Rail saws, Vixen hand milling tools, emery wheels. Represented by W. J. McDowell.

W. W. Mechling, Munhall, Pa.—M. & S. steel tie. Represented by W. W. Mechling and J. E. Smith.

Municipal Engineering & Contracting Co., Chicago.—Chicago improved cube concrete mixer. Represented by C. E. Bathrick, A. Cameron, J. B. Austin and J. Warning.

National Lock Washer Co., Newark, N. J.—Samples of nut locks in National, Harvey ribbed, tail and plain types for every size bolt and all sections of steel. Represented by F. B. Archibald, John B. Seymour and George E. Bake.

National Malleable Castings Co., Chicago.—Malleable track specialties. Represented by F. R. Angell, H. I. Hiatt, J. J. Byers and W. L. Graves.

Geo. P. Nichols & Brother, Chicago.—Electric turntable tractor, photographs of transfer tables and turntable tractors, special appliances for elecric drawbridge equipments. Represented by George P. Nichols and S. F. Nichols.

B. F. Nickerson, Chicago.—The Nickerson safe switch point lock. Represented by B. F. Nickerson.

Gus E. Nyquest, Tribune building, Chicago.—Wrecking frog and mail catcher. Represented by Gus E. Nyquest and Henry Graff.

Osgood Scale Co., Binghamton, N. Y.—Automatic freight scales for L. C. L., freight and baggage automatic scales. Represented by William E. Smith & Co., Chicago.

Otto Gas Engine Works, Chicago.—Radial overcut coal chute spouts and aprons, automatic bucket loader, guard rail clamp, photographs and literature. Represented by T. W. Snow, R. E. Gurley, R. A. Ogle, C. C. Lazenby and H. C. Harnish.

C. F. Pease Blue Print Machinery & Supply Co., Chicago.—A modern blue print plant in operation, consisting of a Pease automatic printing, washing and drying equipment with a Pease cutting and trimming table; also automatic electric blue printing machine and wall washer for separate prints. Represented by C. F. Pease, P. M. Morgan and N. L. Hayden.

Pennsylvania Steel Co., Steelton, Pa.—Solid Manard crossing, Manard anvil face frog, solid Manard frog, Manard spring rail frog, sample never turn split bolt, never slip side plate, new process switch with rolled Manard stock rail, main line safety switch stand, low New Century switch stand, low Steelton positive switch stand, intermediate pony main line switch stand, semaphore switch stand with disappearing blade, Manard pinless switch, rolled Manard rail, drop test specimens of rolled Manard rails and rail testing machine. Represented by Howard F. Martin, C. R. Reinoehl, B. L. Weaver, M. W. Long, William M. Henderson, W. H. Allen, F. A. Robins, Jr., and G. K. Reel.

Percival Wood Preserving Co., Houston, Tex.—Method of wood preservation. Represented by H. W. Graves.

Pittsburg Filter Co., Pittsburg, Pa.—Represented by F. B. Leopold and Willis C. Squire.

Pittsburg Steel Co., Pittsburg, Pa.—Electric welding fence machines manufacturing "Pittsburg Perfect" electrically welded fence for railway use. Represented by E. D. Findlay, F. A. Tower and E. Steytler.

Pocket List of Railroad Officials, New York.—Pocket lists of railway officials. Represented by J. Alexander Brown and C. L. Dinsmore.

The D. & A. Post Mold Co., Three Rivers, Mich.—Concrete post machinery and molds, reinforced cement posts and sections of same. Represented by G. H. Dougherty.

Potter Brothers, 59 Clark street, Chicago.—Reinforced concrete battery vaults, battery chutes and concrete foundation. Represented by Frank H. Potter and A. C. Heidelberg.

The Q & C Company, New York.—Q & C Bonzano joint, step or compromise joint, anti-rail creepers, guard rail clamps and guard rail braces. Represented by C. F. Quincy, E. M. Smith, G. C. Isberton, J. V. Westcott and G. L. Hall.

Rail Joint Co., New York.—Continuous, Weber and Wolhaupter types base supporting rail joints. Represented by L. F. Baine, H. C. Holloway, W. E. Clark, F. A. Poor, V. C. Armstrong, F. C. Webb, E. L. Van Dresar and J. G. Miller.

Railroad Age Gazette, New York, Chicago, Pittsburg and London.—Railroad Age Gazette. Represented by Edward A. Simmons, Ray Morris, Lucius B. Sherman, John N. Reynolds, Samuel O. Dunn, William Forsythe, Charles H. Fry, F. S. Dinsmore, C. R. Mills, Bradford Boardman and Henry Lee.

Railroad Automatic Track Inspector Co., Tacoma, Wash.—Railroad automatic track inspector for making a correct record of the gauge and level of track and location points. Automatic cattle guard, being a new type of guard to turn cattle. Represented by T. Ellis and Willis C. Squire.

Railroad Supply Co., Chicago.—Tie plates, R. R. S. derailer, highway crossing bells and relays, electric block signal relays, train annunciators and indicators, lightning arrestors, electric switch locks, circuit controllers, switch boxes, track insulations and signal maintenance materials. Represented by E. H. Bell, C. P. Cogswell, Jr., M. J. Comerford, E. W. Vogel and A. H. Smith.

Railway and Enginering Review, Chicago.—Represented by Willard A. Smith, Walter M. Camp, A. E. Hooven, P. G. Stevens, C. C. Zimmerman, Harold A. Smith and H. N. Kelley.

Railway Chemical Sprayer Co., Owensboro, Ky.—Photographs of sprayer and literature relating to work of killing vegetation on railroads. Represented by John V. Pearse.

Railway List Publishing Co., Chicago.—Copies Official Railway List. Represented by William E. Magraw.

Ritter Folding Door Co., Inc., Cincinnati, Ohio.—Horizontal folding door for round houses, machine shops, freight depots, etc. Represented by A. Ritter and J. M. Crowe.

Roberts & Schaefer Co., Chicago.—Working model of a Holman-Barrett coaling station, photographs and drawings. Represented by Edward E. Barrett, Clyde P. Ross and James Shannon.

Geo. M. Robinson, 243 Cleveland avenue, Dubuque, Iowa.—Patent metal railway tie. Represented by George M. Robinson.

Scherzer Rolling Lift Bridge Co., Chicago.—Models, photographs, designs, plans, drawings and descriptive literature on Scherzer rolling lift bridges. Represented by John T. Dickerson, H. D. Harting and R. W. Flowers.

J. M. Scott & Sons, Racine, Wis.—Hercules and Little Giant bumping posts and souvenirs of its Holdfast spike cast in aluminum. Represented by John M. Scott and Elbert E. Scott.

Scully Steel & Iron Co., Chicago.—Everlasting blow-off valve, Lucas pneumatic tube expander, Lucas roundhouse expander, Scully railway flue cutter, track and car jacks, track tools, bolts and sledges. Represented by H. C. Finlay, W. H. Dangel, F. K. Maus, F. W. Blume, W. B. Templeton, George Mason, Jr., T. T. Cavanagh and H. H. Gilbert.

Sellers Manufacturing Co., Chicago.—Sellers anchor bottom tie plate, Samson angle bar and other types of angle bars. Represented by J. M. Sellers, J. T. Markham and L. S. Gordon.

Jesse T. Shaw, 862 North Harding avenue, Chicago.—Concrete ties. Represented by Jesse T. Shaw.

Signal Engineer Co., Chicago.—The Signal Directory, The Signal Engineer, Railway Electrical Engineer. Represented by L. B. Mackenzie, A. D. Cloud, A. F. Klink and Fred W. Bender.

Simmons Hardware Co., St. Louis, Mo.—Enameled steel semaphore blades, new Groff track drills and bonding drills. Represented by J. B. Webb, G. W. Simmons and C. B. Groff.

Spencer Otis Co., Chicago.—Railway tie plates. Represented by W. L. DeRemer, H. H. Hart and Carter Blatchford.

Standard Steel Tie Co., Pittsburg, Pa.—Standard steel railway and traction ties, standard rail fasteners, fastener attachments, angle bars, wedge members and appliances. Represented by George M. Cote and J. Harvey Harrison.

Arthur L. Stanford, Railway Exchange, Chicago.—Stanford two piece and three piece rail joints and Stanford bumping post. Represented by Arthur L. Stanford.

Strauss Bascule & Concrete Bridge Co. and Strauss Self Balancing Window Co., Chicago.—Models and photographs of bascule bridges and models and photographs of self balancing windows. Represented by J. B. Strauss.

Stover Motor Car Co., Freeport, Ill.—Motor inspection cars. Represented by M. Mowbray.

Union Switch & Signal Co., Swissvale, Pa.—One arm mechanical signal, rotary circuit controller for semaphore shaft, lever dwarf machine, electrically locked circuit controller and indicator, Union electro-manual block instrument, low base R. S. A. relay, train staff instrument, combination rail clips, inside detector bar clip, Keystone insulated rail joint, Union electric crossing gate post and mechanism and literature. Represented by J. S. Hobson, W. E. Foster, T. H. Patenail and W. M. Vandersluis.

U. S. Metal & Manufacturing Co., New York.—Diamond tapered steel pole, telephone and telegraph lines and trolley poles, Columbia lock nut, structural steel Continental whistling post and the Hillman locked clevis and turnbuckle. Represented by Fred Atwater and Charles R. Day.

U. S. Wind Engine & Pump Co., Batavia, Ill.—Model of Mansfield water column, model of hydraulic valve, model of wood tank supplying locomotive tender, U. S. ground throw switch stand, working sample of low semaphore switch stand, blue prints and literature. Represented by C. E. Ward, A. J. Anderson and L. E. Wolcott.

Variety Manufacturing Co., Chicago.—Cross horizontal folding door, Variety steel rolling shutter, Variety wood slat rolling shutter, cross-compound slide-up door. Represented by W. H. Barry, E. L. Beckerleg, W. B. Gervais and F. E. Kahl.

R. H. Vesey Manufacturing Co., Chicago.—Ideal post hole digger. Represented by F. A. Hoyt.

Vulcan Steam Shovel Co., Toledo, Ohio.—Photographs, blue prints and literature of different sizes and types of steam and electric shovels. Represented by W. S. Russell.

Weir Frog Co., Cincinnati, Ohio.—Literature on Manganese frogs, guard rail clamps and automatic switch stands. Represented by N. O. Goldsmith.

Western Valve Co., Chicago.—Fairbanks valves, Dart union couplings, Dart flange unions. Represented by H. V. Conine, G. W. Conine and B. D. Coffman.

C. H. Whall & Co., Boston, Mass.—Whall's special railroad fibre for insulating rail joints, etc., fusees for train protection. Represented by F. R. Whall.

William Wharton, Jr., & Co., Inc., Philadelphia, Pa.—Manganese steel switches, frogs and crossings, switch stands, guard rail clamps, models of derailing switches, photographs, blue prints and literature. Represented by V. Angerer, Arthington Gilpin, R. C. McCloy, W. McLain and Arthur S. Partridge.

Whiting Foundry Equipment Co., Harvey, Ill.—Photographs of cranes of all kinds, electric travelers, foundry equipment, railway turntable centers and transfer tables. Represented by C. A. Hardy and P. A. Dratz.

Williams, White & Co., Moline, Ill.—Plans and photographs of coaling stations. Represented by George W. Freeland.

Williams Boltless Rail Joint Manufacturing Co., Chicago.—Williams boltless rail joint, Twentieth Century steel tie, automatic lock nut, Smith's reinforced spike, automatic car seal. Represented by Willis D. Williams, Emil Meyer, Cortlandt F. Ames, Charles Rystrom and T. J. Dyke.

Jas. G. Wilson Manufacturing Co., New York.—Rolling steel doors for freight sheds and warehouses, rolling wood doors for engine houses and sliding swing doors designed especially for freight sheds. Represented by H. B. Dodge & Co., Western Agents, Chicago.

Winans Rail Joint Co., 509 DeKum avenue, Portland, Ore.—Rail joints. Represented by Audubon Winans.

Wright Wire Co., Worcester, Mass.—Rust proof truss and cable fence. Represented by J. J. Collins.

Robert J. Zorge, Postal Telegraph building, Chicago.—Automatic torpedo magazine. Represented by Robert J. Zorge.

ANNUAL CONSTRUCTION RECORD.

A

ABBEVILLE & NORTHWESTERN.—Surveys made from Abbeville, Ga., northwest, via Pine View, Unadilla and Emerich, to Fort Valley, 58 miles. Branch from Emerich west to Montezuma, 17 miles. J. L. Bankston, President, Abbeville.

ABERDEEN & TOMBIGBEE.—Building from Okolona, Miss., southeast to Pickenville, Ala., 65 miles; surveyed. Grading finished between Okolona and Aberdeen, 17.5 miles, also Columbus to Pickensville, 11.5 miles. Contract let to S. M. Bush, Memphis, Tenn., for 14 miles from Buttshachi river south to Columbus, Miss. W. T. McKee, Chief Engineer, Aberdeen, Miss.

ABILENE & SOUTHERN.—Plans call for a line from Abilene, Tex., south to Sonora, about 160 miles, with a branch from the main line of Colorado & Southern, near Ballinger southwest to San Angelo, 40 miles. Grading completed between Abilene and Winters 38 miles, track laying under way. Morgan Jones, President of the Wichita Valley, Seymour, Tex., is at the head of the company.

ACME, RED RIVER & NORTHERN.—Projected 45-mile extension from Acme west into Cottle county.

ADIRONDACK & ST. LAWRENCE.—Line is under survey from Hermon, N. Y., to Clifton, 23 miles. H. F. Timerman, Superintendent, Hermon, N. Y.

AJO VALLEY RAILROAD.—Proposed line from Theba, Ariz., south to the Ajo mines, and thence to the Mexican border, about 125 miles. Surveys made. Expected that work will be started shortly. F. A. Bordwell, Chief Engineer, Tucson, Ariz.

AKRON, CANTON & YOUNGSTOWN.—Proposed from Akron, Ohio to Canton and Youngstown. Z. W. Davis, Cleveland, Ohio, is interested.

ALABAMA & MISSISSIPPI.—Building by the Vinegar Bend Lumber Co., Fruitdale, Ala., from a connection with the Mobile & Ohio, near Fruitdale, to timber lands, about 12 miles. N. E. Turner, Vice-President, Fruitdale.

ALABAMA RAILWAY & ELECTRIC CO.—Proposed electric line from Opelika, Ala., south to Eufaula, 60 miles, and eventually to the Gulf. Contracts let for some of the work. J. C. Chapman, Vice-President, Atlanta, Ga.

ALABAMA, TENNESSEE & NORTHERN.—Grading completed from Cochrane, Ala., south to a point in Sumter county, 10 miles.

ALASKA CENTRAL.—Building from Seward, north to Tanana river, 450 miles. Contract to Snow & Watson, for 23 miles. Surveyed to mile 183; also for branch from Knik, mile 150, east to Matanuska, 40 miles.

ALASKA PACIFIC.—Building from Martin Island, near Katalla, Alaska, to Bering river coal fields. Surveyed to Copper river valley.

ALBIA INTERURBAN.—Contract let to Patrick Fitzgerald, Atlantic, Iowa, to build extension from Albia, Iowa, northwest to Hiteman, about 6 miles.

ALBUQUERQUE & EASTERN.—Arrangements said to have been completed for building from Moriarty, N. Mex., on the Santa Fe Central, west via Frost to Albuquerque and Hagan, about 75 miles.

ALEXANDER & EASTERN.—Projected from Alexander, W. Va., northeast to Elkins, about 30 miles. J. B. Hart, Clarksburg, W. Va.

ALEXANDRIA, LEESVILLE & LUFKIN.—Proposed from Lufkin, Tex., east to Alexandria, La., about 140 miles. Preliminary surveys made. Contract for part building of the line let to J. S. Moore, of Lufkin.

ALTON, ST. LOUIS & CAIRO (Electric).—Proposed from Alton, Ill., south through Madison, St. Clair, Monroe, Randolph, Jackson and Union counties, to Cairo, in Alexander county, 130 miles. A branch is also to be built from the main line, west to Waterloo and Columbia, in Monroe county. T. N. Chase, Incorporator.

ALTOONA, HOLLIDAYSBURG & BEDFORD SPRINGS (Electric).—Organized about three years ago to build a line from Altoona, Pa., south, through Hollidaysburg, Newry, Freedom, McKees, Rooring Springs, Sharpsburg, Martinsburg, Curryville, Woodbury, Mario, Waterside, Tatesville and Everett. Rights of way have been secured. Work is to be started shortly on the line, which is intended eventually to extend south to Cumberland, Md., and east to McConnelsburg, Fulton Co., Pa. F. W. Patterson, Altoona, Chief Engineer.

ALTUS, ROSWELL & EL PASO.—Proposed to build from Altus, Okla., west via Duke and Hollis to Memphis, Tex., thence via Silverton, Plainview, Lockney, Petersburg and Lubbock to Roswell, N. M., thence to El Paso, Tex., 400 miles. Grading completed from Altus to Hollis, about 40 miles. The intention is to have this section of the line in operation by June, 1909. McCullough Construction Co., Contractors, St. Louis, Ill.

——Grading completed from Roswell, N. M., east 12 miles. Surveys made from Roswell to a point 50 miles east of Lubbock, Tex., 207 miles.

——Grading under way between Petersburg, Tex., Lockney and Cape Rock. H. H. Fielder, Chief Engineer, Altus, Okla.

ANGELINA & NECHES RIVER.—Building from Prosser, Tex., via Manning and Keltys Front, to Platt, 17 miles. J. H. Kurth, Keltys, Tex.

APPALACHIAN RAILWAY.—Projected from Foering, N. C., via Birdtown and Cherokee to Sevierville, Tenn., about 40 miles. First section from Foering to Cherokee under contract to J. C. Arbogast, contractor, Asheville, N. C. Grading completed for 6 miles and part of track laid. Work will include one 300-ft. bridge. Robert Gray, Chief Engineer, Foering.

ARIZONA & CALIFORNIA.—See Atchison, Topeka & Santa Fe.

ARIZONA ROAD.—Surveys made for proposed line from Flagstaff, Ariz., southwest to Jerome, about 55 miles. Arthur Maguire, Las Vegas, N. Mex.

ARKANSAS CENTRAL.—Building 6-mile extension from Paris, Ark.

ARKANSAS, LOUISIANA & GULF.—Building from Monroe, La., north to Pine Bluff, Ark., with a branch to Crossett, Ark., in all 143 miles. Built from Bastrop, north to Hamburg, 3.3 miles; also 5.2-mile branch to Crossett. The 80-mile further extension from Hamburg to Pine Bluff has been surveyed, and grading begun.

ARKANSAS, OKLAHOMA & WESTERN.—Surveys made for extensions from Rogers, Ark., northeast to Eureka Springs, 30 miles, and from Siloam Springs, Ark., west to Pryor Creek, Okla., 65 miles. Contract let for some of the work to the W. R. Felker Construction Co., Rogers, Ark.

ARKANSAS ROADS.—Grading contracts have been let to W. A. Dennison and to L. J. Smith for building about 7 miles of line from the mill of Moore & McFerren at Ross, Ark., which is on the Jonesboro, Lake City & Eastern, to a connection with the projected Lee Wilson Railway, which in turn is to connect with the St. Louis & San Francisco at Wilson. G. H. Pulford, of Luxora, Ark., Engineer in charge.

——Surveys made for a line from Mountain Home, Ark., south to a connection with the St. Louis, Iron Mountain & Southern, 11 miles. W. L. Marshall, Mountain Home, is interested.

ARKANSAS SOUTHEASTERN.—Proposed extension from River Junction, La., south to Farmerville, 5 miles. S. R. Neal and N. M. George, Contractors, Farmerville.

ARTESIAN BELT.—Plans call for a line from Macdona, Tex., south via Kirk, Fruitland, Poteet, Brooklyn, New Pleasanton and New Artesia to Simmons City. Contract has been given to J. F. Burns, of Divine, for the grading and track laying on the first 40 miles. Track laying begun on first section. Wm. Bradburn, Chief Engineer, 215 Alamo Plaza, San Antonio, Tex.

ASHERTON & GULF.—The Nueces Valley, Rio Grande & Mexico, now the A. & G., was organized to build from Eagle Pass, Tex., east to Aransas Pass, about 300 miles. Work now under way by the J. F. Burns Construction Co., contractor, Devine, Tex., on the 32-mile section from Artesia, Tex., west to a point on the I. & G. N. at Asherton, Dimmet county. Grading finished on 20 miles and track-laying underway. R. H. Gresham, Ch. Engr., Artesia.

ASHEVILLE & GREENVILLE (Electric).—Contracts let to Carolina Construction Co., Raleigh, N. C., to build an electric line from Asheville, N. C., south via Hendersonville to Greenville, S. C., 60 miles. J. F. Rowland, President, 301 Oatch building, Nashville, N. C.

ASHEVILLE & HENDERSONVILLE (Electric).—Surveys made from Asheville, N. C., to Hendersonville, 22 miles. C. F. White, Ashville, N. C., is interested.

ATCHISON, TOPEKA & SANTA FE.—Projected extension of the Pecos & Northern from Texico, N. Mex., the eastern end of the Belen cut-off, southeast via Plainview, Tex., Floydada, Dickens, Aspermont, Hamlin, Anson and Abilene, to Brownwood, Tex., on San Angelo branch of Gulf, Colorado & Santa Fe, about 300 miles is to be built when conditions are more satisfactory. This would give the Santa Fe a short through line from San Francisco to Galveston.

——The Arizona & California projected from Wickenburg, Ariz., on Santa Fe, Prescott & Phoenix, west to Bengal, Cal., on main line, 205 miles. In operation from Wickenburg west 113 miles to the Colorado river. Bridge over Colorado river completed. No new construction work was done during 1908 on the projected extension from the Colorado river bridge west to a junction with the main line at Bengal, Cal., 92 miles, but will be carried out when conditions warrant further work.

——A reasonable amount of ballast work on the extension between Point Richmond, Cal., and Bakersfield to be done during the present year.

——See Gulf, Colorado & Santa Fe.

ATLANTA, BIRMINGHAM & ATLANTIC.—Work suspended on branch from Bessemer, Ala., to Mulga, 14.5 miles. Lane Bros. Co., Atlanta, Ga., and C. D. Smith & Co., Birmingham, Ala., contractors.

——Western extension from Talladega, Ala., is completed to Pelham and trackage rights secured over the L. & N. into Birmingham. Work on the 19 miles from Pelham to Birmingham suspended.

ATLANTA NORTHEASTERN (Electric).—Surveys made from Atlanta, Ga., through the counties of Fulton, Cobb, Milton and Forsythe, to Cumming, 42 miles. T. F. Martin, Atlanta, Ga., is interested.

ATLANTIC COAST LINE.—Contracts let to Wade & Bell, Trinity, Fla.; Wade & Morrison, Washington, N. C., and Phillips & Allport, Richmond, Va., for building extension from Wilcox, Fla., northwest to Perry, 55 miles, for a change of line at Goldsboro, N. C., 4 miles, and a change of line at St. Mary's river, Fla., 1.5 miles. Surveys made for a change of line 4 miles long at Inverness, Fla. Work of double-tracking between Folkstown and Callahan under way.

ATLANTIC, NORTHERN & SOUTHERN.—Operating 17 miles from Kimballton, Iowa, south to Atlantic. Extensions, north from Kimballton to Manning, 20 miles, and south from Atlantic to Villisca, 39 miles, under way. Ross & Judd, Atlantic, Iowa, Contractors.

AUGUSTA & EDGEFIELD (Electric).—Projected from Augusta, Ga., north, via Edgefield, S. C., to Greenwood. Surveys completed and contracts for grading and track laying let. W. P. Calhoun, Chairman, Edgefield, S. C.

AUGUSTA SOUTHERN—Revision of grades and curves under way.

B

BALLINGER & ABILENE.—Organized in 1907 to build a line from Ballinger, Tex., north to Abilene, 55 miles. Contracts let. W. J. McDaniel, Chief Engineer, Ballinger.

BALTIMORE & OHIO.—Contract let for 4 miles, single-track road in Georgetown, D. C., and to boundary of the District of Columbia. The line will be part of the Washington & Western Maryland, owned by the B. & O. It is ultimately intended to operate the line in connection with the Metropolitan Southern, a branch of the Baltimore & Ohio from Linden, in Montgomery county, Md., to the Potomac river. Finished from Lindon to Chevy Chase. A link five miles long is to be built to join this with the Washington & Western Maryland at the District line. C. A. Sims & Co., Contractors, Philadelphia.

BALTIMORE & WASHINGTON (Electric).—Proposed from Washington, D. C., to Sandy

Spring, Md., 14 miles. W. A. Mellen, General Manager, Washington, D. C.

BAKERSFIELD & VENTURA.—Building from San Francisco, Cal., southeast via Santa Paula, thence southwest to Ventura, on the Pacific coast, with franchises from Sunset northeast to Bakersfield, and from Saticoy south to Hueneme, on the Pacific coast, a total of 370 miles. Branch also projected from Santa Paula southeast to Santa Monica, thence east to Los Angeles, 50 miles. 20 miles finished. T. B. Blackburn, Ch. Engr., Oxnard, Cal.

BANGOR & AROOSTOOK.—Projected north from the main line at Seboois, Me., along the east bank of the Allagash river to St. Francis, 140 miles. Surveys made over the most difficult parts.
——Contract for building line from Baton Rouge, La., east, let to John Scott & Sons, Contractors, St. Louis, Mo. Work under way between Baton Rouge and Hammond.

BAYFIELD TRANSFER.—Projected from Bayfield, Wis., west to Superior, 70 miles.

BAY POINT & CLAYTON.—Projected from Bay Point, Cal., southeast to Clayton. Finished to Cowell 10 miles. Surveyed from Cowell to Clayton, 3 miles and from Bay Point station to Bay Point landing, 1½ miles. W. H. George, Secretary and General Manager, San Francisco.

BEAUMONT & SARATOGA TRANSPORTATION.—Extension projected from Saratoga to Batson, 15 miles.

BEAVER VALLEY & NORTHWESTERN.—Projected from Gage, Okla., thence west via Hooker to Guymon, on the Atchison, Topeka & Santa Fe, northwest to Beaver. It is intended ultimately to extend the line northwest to a connection with the Atchison, Topeka & Santa Fe in Kansas. Survey from Gage to Hooker made. Contract let to T. E. Luttgerding, Contractor, Wichita, Kans. J. W. Webb, President, Beaver.

BEAVERTON & WILLSBURG.—See Southern Pacific.

BESSEMER & LAKE ERIE.—Extending second track at several points where grading was completed in 1907, in total about three miles. H. T. Porter, Chief Engineer, Greenville, Pa.

BIENVILLE-QUITMAN.—Projected from Bienville, La., east to Quitman, 12 miles. Contracts let and work under way. Track laid on 2 miles. Richardson-Taylor Lumber Co., contractors. E. E. Scott, Chief Engineer, Bienville, La.

BIG BEND TRANSIT CO.—Projected from Spokane, Wash., west along the Little Spokane river to Metre rapids. Grading has been completed for 7 miles on the western end. Wm. A. Nichols, President, 105 Howard street, Spokane, Wash.

BIG STONY.—See Norfolk & Western.

BILLINGS & COOKE CITY ELECTRIC.—Proposed from Absarokee, Mont., northeast to Billings. Surveys made and grading will begin as soon as the right of way is secured. J. B. Clayberg, Helena, Mont.

BIRMINGHAM & GULF RAILWAY & NAVIGATION CO.—Projected from Tuscaloosa, Ala., northeast via Birmingham to Gadsden, about 120 miles. The company has bought the Tuscaloosa Belt Railway, a 12-mile belt line at Tuscaloosa, eight river steamboats and a number of barges, which are being operated on the Alabama river from Montgomery, Ala., via Selma to Mobile, and from Tuscaloosa, via Demopolis to Mobile. J. L. Pultz, Genl. Mrg., Mobile.

BIRMINGHAM, COLUMBUS & ST. ANDREWS BAY.—Contracts let to Lemuel E. Miller, Philadelphia, for building from Green Head, Fla., to St. Andrews Bay, 38 miles. Grading under way by J. M. Willis, from Sodom to Taylers, 10 miles.
——Work under way on an extension from Morrison, Fla., to Green Head, 5 miles.

BITTER ROOT.—Proposed from Lewiston, Idaho, east to Butte, Mont., about 350 miles. Surveys made from Lewiston to Clearwater river, 85 miles. G. W. Boschke, Ch. Engr.

BLOOMINGTON, PONTIAC & JOLIET. (Electric).—In operation from Dwight, Ill., southwest to Pontiac, 20 miles. Extension projected from the latter place southwest to Bloomington, 35 miles.
——See Joliet & Southern Traction.

BLUE RIDGE TRACTION.—Proposed extension to various points aggregating 16 miles. The principal extension will be through Cherryville, Pa., Weaversville and Bath. A bridge is also to be built at Alliance.

BONLEE & WESTERN.—Proposed to build 14 miles of railway in North Carolina in Chatham and Randolph counties. Work under way west from Causey, N. C. J. H. Dunlap, President, Ft. Dillon, S. C.

BOSTON ELEVATED.—Work on the Cambridge main street subway postponed, awaiting approval of plans of stations by the Railroad Commissioners.
——Plans for the route from Sullivan Square, Charleston, to Malden, about 3 miles, are now before the Railroad Commissioners.
——Legislature authorized building of subway from the present Park street station in the Tremont street subway, west under Boston Common to south bank of Charles river, and under Charlesbank to beyond Harvard bridge. To be used by trolley cars for Newton, Brighton, Allston and other outlying points. Work not to be begun for some months yet.
——Extension from North station, Boston, to East Cambridge proposed for near future. Contracts for foundations for Charles river bridge let.
——Contracts let for station at Forrest Hills Square, George A. Kimball, Chief Engineer, Boston, Mass.

BRINSON RAILWAY.—Proposed extension Springfield, Ga., northwest to Sylvania, 32 miles.

BROOKINGS & SIOUX FALLS (Electric).—Intend to build from Brookings, S. Dak., via Flandreau to Sioux Falls, 65 miles. Grading completed from Brookings to Erico, 15 miles. Line under contract from Brookings to Flandrau, 28 miles, Western Construction Co., Brookings, S. D., Contractors. I. A. Smith, Chief Engineer. St. Louis, Mo.

BUENA VISTA & MAUK—Proposed 18 miles from Mauk, Ga., southwest to Buena Vista. E. B. Hornady, of Buena Vista, Ga.

BUFFALO, ROCHESTER & PITTSBURGH.—Main line improvements under way near Punxsutawney, Pa.

BURR'S FERRY, BROWNDEL & CHESTER.—Projected from Rockland, Tex., east via Browndel and Burkville, to Burr's Ferry, on the Sabine river, 86 miles. Grading completed from Rockland to Browndel, 28.5 miles. Track laid to Ellis Hill, 11.5 miles. Hope to complete laying steel on remaining 17 miles this summer. Work suspended. There will be a 200-ft. steel bridge over the Angelina river. P. G. Omohimdro, Ch. Engr., Beaumont.

C

CAIRO & KANAWHA.—Proposed extension from Macfarlan, W. Va., to Smithville, 8 miles.

CAIRO & THEBES.—Building from Cairo, Ill., northwest to Thebes, 25 miles. J. L. Armstrong, Ch. Engr., Cairo.

CALIFORNIA CO.—Proposed from Richardson's Bay, Cal., northeast to Sacramento, about 90 miles. Branch lines from Gallinas creek north to Petaluma, 18 miles, and from the Stanley lands north to Napa, 5 miles. Surveys made for a route from Richardson's Bay to Tiburon, San Quentin, Point Pedro, Petaluma, and thence northeast to Sacramento. Charles W. Conlisk, stockholder, San Francisco.

CALIFORNIA, NEVADA, IDAHO & NORTHERN. Work is under way on the line from Caldwell, Idaho, west to Homedale, 17 miles. Surveys made beyond Homedale south to Jordan Valley, Ore., 60 miles. Canyon Construction Co., contractors, Caldwell. F. H. Richardson, Chief Engineer, Caldwell.

CALIFORNIA NORTHEASTERN. — See Southern Pacific.

CAROLINA & TENNESSEE SOUTHERN.—See Southern.

CAROLINA, CLINCHFIELD & OHIO.—Work on the southern end of this line from Bostic, N. C., south to Spartanburg, S. C., 32 miles, is progressing rapidly. The McArthur Bros. Co., Spartanburg, S. C., has contract for this work, and have given sub-contracts for 18 miles, as follows: Bostic to Second Broad River, five miles, J. Nichols, Parkersburg, W. Va.; Second Broad River to Floyd Creek, five miles, Purcell, Allen, Shehan & Co., Washington, D. C.; Broad River to Little Buck Creek, Williams, Lewis & Spradlin, Atlanta, Ga.; Pacolet River to Peters, three miles, to Reagan & Yale. Most of the heavy masonry work has been let to J. C. Dunn, Cleveland, Ohio, and Thomas Shehan, Nashville, Tenn. The trestle work has been awarded to H. J. Collier & Co., Cleveland, Ohio. Should be completed by May 15, 1909.

CAROLINA VALLEY.—Projected extension from Thomasville, N. C., northeast, via Highpoint, to Greensboro, 22 miles; also from Highpoint northwest to Winston-Salem, 21 miles. Work under way on 12 miles.

CANADIAN RIVER RAILROAD.—See Santa Fe, Liberal & Englewood.

CAZENOVIA & SAUK CITY. — Proposed from Lavalle, Wis., south, via Ironton, Cazenovia, Lineridge and Logansville to Sauk City, about 40 miles. Right of way secured for part of line. Contracts for construction not yet let. Joseph Duren, Cazenovia, Wis.

CENTRAL ARKANSAS (Electric).—Proposed from Little Rock, Ark., southeast to Pine Bluff and southwest to Hot Springs, about 90 miles. Preliminary surveys made and some of the right of way secured.

CENTRAL CALIFORNIA.—See Southern Pacific.

CENTRAL KENTUCKY TRACTION.—Proposed from Lexington, Ky., south to Nicholasville, 12 miles. J. B. Crawford, General Manager, Lexington, Ky.

CENTRAL RAILROAD OF LOUISIANA.—Proposed from Leesville, La., to New Orleans, 242 miles. Work under way. C. L. Provost, New Iberia, Chief Engineer.

CENTRAL TEXAS TRACTION.—Proposed from Corsicana, Tex., southeast to Palestine, 60 miles. W. W. Clopton and J. V. Watkins, of Corsicana, are interested.

CHAMPLAIN & SANFORD.—Organized last year to build a line from Lake Sanford, N. Y., southeast to Schroon lake, thence along the west shore of Schroon lake, through Pottersville and Chester, to Riverside on the Adirondack division of the Delaware & Hudson. Surveys made. A. Thompson, President, Albany, N. Y.

CHARLESTON & SUMMERVILLE (Electric).—Contract let to the General Contracting & Engineering Co., New York, to build from Charleston, S. C., northwest to Summerville, 27 miles. Grading finished on 23 miles. Julius G. Hocke, President, New York; George Tupper, Secretary-Treasurer, Summerville, S. C. W. O. Sprigg, Ch. Engr., 15 Whitehall street, New York.

CHARLESTON, PARKERSBURG & WESTERN.—Track laid for 30 miles on the line building from Charleston, W. Va., north to Parkersburg, 60 miles. Engineering work under way on the rest of the line, but undecided when grading will be begun. C. P. Peyton, Ch. Engr., Charleston.

CHARLESTON & WESTERN CAROLINA.—Rebuilding yard tracks along the Savannah river at Augusta, Ga., which were carried away by high water. Improvements will include a total of 6,000 ft. of trestle work.

CHARLOTTE HARBOR & NORTHERN.—Extension from Arcadia to Plant City, 60 miles, surveyed and right of way secured.

CHATTAHOOCHEE VALLEY.—Proposed extension from West Point, Ga., north through Troup county, Ga., to Standing Rock, in Chambers county, Ala., thence to a point near Texas in Heard county, Ga.

CHESAPEAKE & OHIO.—The Raleigh & Southwestern, building from the Piney branch at Raleigh, W. Va., up the Piney river and over the divide, thence down the tributaries of the Guyandotte river in Raleigh or Wyoming counties; also extension from Raleigh up Beaver creek into the Glade creek valley. Johnson & Briggs, Richmond, Va., contractors. Work suspended July 1, 1907, and not yet resumed.
——During 1908 track was laid for about two miles on the extension of the Potts Creek branch from Jordan, Va., to Bess. No further extension intended at present.
——Double-tracking between Morrison, Va., and Lee Hall and between Lightfoot and Diascund. Grading completed, track laying in progress.
——Double-tracking between Gauley, W. Va., and Kanawha Falls. Pitts & Calligan, Kanawaha Falls, W. Va., contractors.
——Extension of the Coal River Railway on Little Coal branch completed and track laid to mouth of Laurel Fork. Under construction from Clothier up Laurel Fork, 5 miles. G. E. McComas, Madison, W. Va., contractor.
——Grading work on the double-tracking work and change of line between St. Albans, W. Va., and Barboursville, about 30 miles, which was suspended in 1907, was resumed in June, 1908, and is still being carried on. Grading about 85 per cent. completed and tracklaying started. Rinehart & Dennis Co., Washington, D. C., Johnson & Briggs, Richmond, Va., and J. C. Carpenter & Co., Clifton Forge, Va., contractors for grading and masonry.

CHESTNUT RIDGE.—Work under way on extension from Millport, Pa., south to Palmerton, 2 miles. Extension projected from Kunkletown north to Saylorsburg 8 miles.

CHESTERFIELD & LANCASTER.—Extension projected from Croburk, S. C., north to Monroe or Charlotte, N. C., 20 to 40 miles.

CHICAGO & NORTH WESTERN.—Work under way on track elevation and a new passenger station in Chicago.

CHICAGO, INDIANAPOLIS & EVANSVILLE.—Proposed from Indiana Harbor, Ind., south through Indianapolis to Evansville, 346 miles. Contract let to Carter Construction Co., contractors. Branch from Logansport, Ind., north to South Bend, 70 miles. William Kenefick, President; J. B. Carter, Vice-President; C. A. Dunneen, Secretary, and R. Zenkere, Treasurer, Indianapolis, Ind.

CHICAGO, LAKE SHORE & SOUTH BEND (Electric).—Building from South Bend, Ind., west to Chicago, Ill., 71 miles. It is expected to have the entire line in operation by April 1. J. B. Hanna, President, South Bend.

CHICAGO, MILWAUKEE & GARY.—Projected extension from Rockford, Ill., north via Beloit, Wis., and Janesville to Milwaukee, 100 miles.
——Projected extension from Momence, Ill., north to Gary, 42 miles. Surveys made and rights of way secured.

CHICAGO, MILWAUKEE & PUGET SOUND.—From Maplevalley east there is about 18 miles of track to be laid. Johnson creek tunnel, 1,985 feet long, is about completed. Track to be laid to the Columbia river, about 24 miles, and the Columbia river bridge will be completed soon. Track laid from the Columbia river to the west end of St. Paul Pass tunnel in the Bitter Root mountains, which latter will be completed in April. Track laying between Missoula and Garrison under way.
——Grading completed on last strip within city limits of Tacoma, Wash., comprising a cut varying from 8 to 12 ft. deep, between East D street and Pacific avenue, about a block and one-half long. Tracklaying under way.

CHICAGO, OTTAWA & PEORIA.—Work under way on a 16-mile branch from Streator, Ill., north to a connection with the main line at Ottawa. W. B. McKinley, President, Champaign, Ill.
——See Western Railways & Light Co.

CHICAGO, ROCK ISLAND & GULF.—Surveys made from Graham, Tex., west to Thockmorton, on the proposed extension from Graham, Tex., west to Haskell, about 75 miles. J. B. Ware Construction Co., contractors, St. Louis, Mo. Grading in progress.
——See Chicago, Rock Island & Pacific.

CHICAGO, ROCK ISLAND & PACIFIC.—Projected cut-off line from Amarillo, Tex., west to Tucumcari, N. Mex., 110 miles. Completed from Amarillo, west, to to Eldorado, 21 miles. Work to be resumed on the remaining 90 miles this Spring.
——Projected cut-off from Mangum, Okla., southeast through western Texas, across the corner of New Mexico via Carlsbad, to El Paso, Texas. J. B. Ware Construction Co., contractors, St. Louis, Mo.

CLEAR LAKE & SOUTHERN (Electric).—Proposed from San Pablo bay, Cal., north via Napa, to Lakeport, on Clear Lake, 135 miles. Surveys made. LeGrand Brown, Chief Engineer, 34 Ellis street, San Francisco, Cal.

CLEVELAND, CINCINNATI, CHICAGO & ST LOUIS.—Surveys being made under charter of the Evansville, Mt. Carmel & Northern from Mt. Carmel, Ill., south to Evansville, Ind., 43 miles.

CLEVELAND SHORT LINE.—Building an 18-mile belt line around Cleveland, Ohio. Located from West Park, 7 miles west of Cleveland southeast to near the Cleveland city limits, thence east and northeast toward Collinwood. In southeast Cleveland the line passes under the main streets; also under the tracks of the Pennsylvania Lines, the Erie and the Wheeling & Lake Erie, through double-track tunnels 40 ft. below the surface. A viaduct 1,980 ft. long will carry it over the Cuyahoga river. There are no grade crossings. The line will furnish interchange facilities between all railways entering Cleveland. Work started in May, 1906. Contracts all let to John Marsch, Cleveland, for grading and masonry, and the King Bridge Co. and the American Bridge Co. for bridges on the section from Rockport to the Cuyahoga river south of Cleveland. Grading, masonry and bridges completed. Track laid for 4 miles. S. Rockwell, Chief Engineer, Cleveland.

CLINTON, OKLAHOMA & WESTERN.—Projected from Clinton, Okla., on the St. Louis & San Francisco and the Kansas City, Mexico & Orient, northwest, via Butler, Hammon and Cheyenne to the Okla.-Texas state line on the Canadian river, 125 miles. First section of line from Clinton to Butler under contract to B. Adams, contractor, Clinton. Grading under way. C. C. Godman, President, Clinton.

COAL & COKE.—Projected extension of the Sutton branch from Gassoway, W. Va., east via Sutton, to Wolf's Creek, 8¼ miles. Contract not yet let. R. H. Pembroke, Chief Engineer, Elkins, W. Va.

COAL RIVER.—See Chesapeake & Ohio.

COLORADO, COLUMBUS & MEXICAN.—Proposed from Columbus, N. Mex., on the Mexican border, north to Golup, Colo., about 300 miles. Surveys made. A. O. Bailey, Columbus, N. Mex.

COLORADO & MEXICO.—Proposed from Douglas, Ariz., via Sulphur Springs valley to Cortland, 40 miles. Entire line is under construction. Powers & O'Connor, contractors, El Paso, Tex. J. L. Campbell, Chief Engineer, Bisbee, Ariz.

COLORADO & NORTHERN. Proposed from Hayden, Colo., to Cottonwood, 15 miles. Paul Blount, Chief Engineer, Denver, Colo.

COLORADO & SOUTHERN.—Terminals being built by the Galveston Terminal Co., at Galveston, Tex., to cost $5,000,000.

COLORADO, HEREFORD & GULF.—Construction under way from Hereford, Tex., southwest to Adrian, 36 miles. South Western Engineering & Construction Co., contractors.
——Proposed from Dalhart, Tex., southwest to San Angelo, 420 miles.

COLORADO, TEXAS & MEXICO.—Proposed from Mangum, Okla., southwest to Comfort, Tex., about 510 miles. 79 miles graded. All surveys made. The Colorado Construction Co., contractors, Mangum, Okla.

COLORADO TRANSPORTATION CO.—See Kansas-Colorado.

COLORADO & WYOMING.—Surveys made for a 6-mile extension from Tercio, Colo., northwest to Stonewall. Grading finished from Tercio to Cornell, 3 miles, but no track laid. J. Coan, contractor, Tercio. R. M. Hosea, Ch. Engr., Pueblo, Colo.

CORSICANA-PALESTINE INTERURBAN.—Surveys made and right of way secured for line from Corsicana, Tex., southeast to Palestine, about 60 miles. G. A. Duren, Chief Engineer, Corsicana.

CORVALLIS & ALSEA RIVER.—Building logging road from Corvallis, Ore., via Monroe to Alsea river 25 miles; 23 miles graded between Corvallis and Glenbrook and 17 miles of track laid, from Corvallis to Monroe. Floyd Bogue, Chief Engineer, Corvallis.

CUMBERLAND RAILROAD.—Contracts let to S. P. Condon, of Knoxville, Tenn., for extension from Artemus, Knox county, Ky., south to Jellico, Tenn., 32½ miles. Track laid from Artemus to Cumberland, 8.2 miles. B. C. Milner, Ch. Engr., Warren, Ky.

CUMBERLAND RIVER & NASHVILLE.—Contracts let to the Monticello Construction Co., of Monticello, Ky., to build from Burnside, Ky., southwest to Monticello, 20 miles; graded for 12 miles, and foundations being built for South Fork bridge. Projected from Corbin, Ky., west to Burnside, and thence southwest to the Tennessee State line, 100 miles, and from this point under the name of the Nashville & Northeastern to Clarksville, Tenn., 60 miles. S. Woodward, President, Carlisle building, Cincinnati, Ohio.

D

DAKOTA & WESTERN.—Projected from Rapid City, S. Dak., southwest to Hill City, 20 miles. Grading completed, but no track laid. A. M. Lamphere, Ch. Eng., Rapid City.

DAYTON, LEBANON & CINCINNATI.—Building from Dayton, Ohio, south to Lebanon, where connection will be made with the Cincinnati, Lebanon & Northern. Twenty-seven miles in operation. Surveyed from Lambeth, Ohio, to Dayton, 2 miles and contracts let. W. E. Johnson, Ch. Engr., Lebanon, Ohio.

DELAWARE & EASTERN.—Proposed northern extension to be built by the Schenectady & Margaretsville from Arkville, N. Y., via Holcotville and Roxbury, to Schenectady, 81 miles. Grading to be started this spring. Work includes one tunnel and two steel viaducts.
——Proposed southern extension to be built by the Hancock & East Branch from East Branch, N. Y., southwest to Wilkesbarre, Pa., 160 miles.

DELAWARE, LACKAWANNA & WESTERN. Work under way on the 28-mile cut-off from Lake Hopatcong, N. J., to Andover, through Warren county to Slateford, Pa., in seven sections as follows: Section 1, 2½ miles, to Timothy Burke, Scranton, Pa. Section 2, 2 miles, to Waltz & Reece Construction Co., Billings, Mont. Section 3, 4½ miles, to David W. Flickwir, Roanoke, Va. Section 4, 5½ miles, to W. H. Gahagan, Brooklyn, N. Y. Section 5, 5 miles, to Hyde, McFarlin Co., New York. Section 6, 5 miles, to Reiter, Curtis & Hill, Philadelphia, Pa. Section 7, 3½ miles, to Smith, McCormick Co., Easton, Pa.

DELAWARE TUNNEL RAILROAD CO.—Charter granted to this company, which proposes to build a tunnel under the Delaware river from Second and Market streets, Philadelphia, Pa., to the New Jersey line, where connection will be made with the tunnel to be built by a New Jersey corporation from the Camden, N. J., side of the river. Contracts will be let as soon as the general plans are completed. W. A. Stern, President, Philadelphia, Pa.

DENVER & RIO GRANDE.—Double-tracking from Florence, Colo., west to Canyon City, 8.3 miles.

DENVER & SOUTH PLATTE (Electric).—Projected from Denver, Colo., to Roxbury Park, 20 miles. Five miles in operation, connecting with line of the Denver City Tramway, at Englewood. No contracts yet let for remaining 15 miles.

DENVER, LARAMIE & NORTHWESTERN.—Projected from Denver, Colo., north and west, via Fort Collins, Colo., Laramie, Wyo., and Granger, to Seattle, Wash., 1,400 miles. Graded for 70 miles on the most expensive and heaviest section of the line, and the 700-ft. trestle at Sand creek (Denver) completed. Grading contract let to Frederick B. Orman & Co., contractors for first section from Denver to Fort Collins. R. H. Dwyer, General Manager, Denver.

DENVER NORTHWESTERN & PACIFIC.—Work under way on extension from Steamboat Springs toward the Colo.-Utah State line, about 145 miles. The line is being built from Denver, Colo., west to Salt Lake City, Utah, 490 miles. In operation from Denver to Steamboat Springs, 229 miles.

DES MOINES & SIOUX CITY (Electric).—Proposed from Des Moines, Ia., northwest to Sioux City, about 192 miles. Most of right of way secured. Contract for construction of line let to American Engineering Co., contractors, Indianapolis, Ind. M. H. Miller, General Manager, Des Moines, Ia.

DINWIDDIE & GARY.—Organized to extend the Chicago & Wabash Valley from Dinwiddie, Ind., via Merrillvill, Lottesville, Glen Park. Grading completed north from Dinwiddie, 4 miles and track laid on 3 miles. C. J. Hobbs, Chief Engineer, Kersey, Ind.

DULUTH & IRON RANGE.—Work under way at Two Harbors, Minn., on a new yard, to contain 6.2 miles of track. Jones Bros., contractors, Cincinnati, Ohio.

DULUTH & NORTHERN MINNESOTA.—Surveys made in Minnesota for an extension from Finland, north 120 miles.

DURHAM & CHARLOTTE.—Extension projected from Gulf, N. C., northeast to Pittsboro, 15 miles.

DYERSBURG NORTHERN.—Extension projected from Tiptonville, Tenn., to Bottom Number Nine, 9 miles.

E

ELDORADO, MARION & SOUTHWESTERN.—Under construction from Pittsburgh, Ill., to Allegheny, 6 miles. Surveyed from Allegheny to Eldorado, 20 miles.

ELKINS ELECTRIC.—Building, with its own men, an electric line from Elkins, W. Va., via Roaring Creek Junction, Harding, Junior, Belington, Clara, Meadowville, Kalamazoo, Nestorville, Danville, Claud and Knotsville to Grafton, 43 miles. The maximum grade is to be 1.5 per cent.; maximum curvature, 10 deg. Track has been laid on two miles. P. B. Bloomfield, Ch. Engr., Elkins.

EL PASO & KANSAS CITY SHORT LINE.—Projected from the southern boundary of New Mexico at the Texas state line east through the Guadalupe mountains along the Pecos valley, crossing the Pecos river at Malaga, thence northeast into the Panhandle of Texas. Surveyed in Texas through the counties of Yoakum, Gaines, Terry, Lynn Lubbock, Crosby, Floyd, Motley, Cottle and Hardeman to Quanah, where connection is to be made with the St. Louis & San Francisco. Rights of way for about 480 miles secured. Col. J. L. Bell, of El Paso, Tex.

ENID, OCHILTREE & WESTERN.—Projected from Enid, Okla., west via Ochiltree, Tex., and Hansford to Dalhart, about 265 miles. Most of surveys made and

rights of way secured. The present plans provide for building the first 100 miles from Dalhart, east to Ochiltree. On this section the grade will not exceed one-half of 1 per cent., and there will not be any bridges and only a few culverts. A E. Wiest, Jr., Vice-President and General Manager, Dalhart, Tex.

ERIE.—Improvement work under way on Jersey City terminal. Plans provide for a 4-track open cut 70 ft. deep and 4,500 ft. long through Bergen Hill for passenger trains. The tracks will run on an elevation in the city east of the tunnel to a new station. The present tunnel will be used for freight trains. The company has bought a large tract of land at the western end of the tunnel, and the city has vacated five blocks on the meadows. Work includes excavating about 120,000 cu. yds. of earth and 480,000 cu. yds. of rock, and building 15,000 cu. yds. of concrete masonry. The Penhorn Creek Railroad incorporated to build this line, 4.74 miles. Contract let to the Millard Construction Co., Philadelphia, Pa.
——Work under way on the Genesee River Railroad from Hunts, N. Y., south to Cuba, 33 miles, as follows: Hunts to Rossburg, Millard Construction Co., Philadelphia, Pa.; Rossburg to Black Creek, W. H. Coverdale & Co., New York; Black Creek to Cuba, Bennett & Smith, Wilkinsburg, Pa.
——Double-tracking from Carrollton, N. Y., to Cuba, 25 miles. Five miles finished; work suspended.

ESTACADO & GULF.—Projected from Roby, Tex., southeast, via McCaulley, Grider and Abilene, to Coleman, 100 miles. Completed from Roby to McCaulley and grading finished to Grider.
——Branch projected from Grider to Stamford, 20 miles. Surveys made and grading will begin about April 15th.

EVANSVILLE & EASTERN RAILWAY.—Projected from Rockport, Ind., east via Grandview, Troy, Tell City and Cannelton to New Albany, and across the Ohio river to Louisville, Ky. C. H. Battin, director, Evansville, Ind.

EVANSVILLE, MT. CARMEL & NORTHERN.—See Cleveland, Cincinnati, Chicago & St. Louis.

EVANSVILLE, MT. CARAMEL & OLNEY (Electric).—Projected from Evansville, Ind., northwest to Olney, Ill., about 60 miles. Surveyed. A. Knoop, President, Olney.

EVERETT RAILWAY, LIGHT & WATER CO.—See Seattle-Everett Interurban.

F

FLORIDA EAST COAST.—Building from Knight's Key, southwest along Florida keys to Key West, about 45 miles. Work includes construction of concrete roadbed on the corral formations of the Keys. From Key West north, track is laid on part of line.

FORT WAYNE & SPRINGFIELD (Electric).—Surveys completed and grading on the remaining 11½ miles to be started as soon as weather conditions permit. Construction work will include one 49-ft. bridge.
——Extension from Decatur, Ind., south via Monroe to Berne, 12 miles.
——Surveys completed on extension from Berne to Portland. Time of beginning grading not decided.

FORT WORTH, WEATHERFORD & MINERAL WELLS INTERURBAN.—Projected from Fort Worth, Tex., west via Weatherford to Mineral Wells, 55 miles. Surveys made by Baxter Brown, St. Louis, Mo.

FRANKLIN & ABBEVILLE.—Extension projected from David Junction, La., north to Youngsville, 15 miles, and from F. & A. Junction south to Franklin, 6 miles.

FRANKLIN & CLEARFIELD.—See Lake Shore & Michigan Southern.

G

GAINESVILLE, WHITESBORO & SHERMAN (Electric).—Proposed from Gainesville, Tex., via Whitesboro to Sherman, 39 miles. Grading finished on 12 miles. Track laying has been indefinitely postponed. L. M. McArthur, Chief Engineer, Stanford, Tex.

GALATIA, HARRISBURG & SOUTHWESTERN.—The property and holdings, including the right of way of the Harrisburg & Ohio River, bought by this company. Branch now building will connect with the Illinois Central at Galatia and extend northeast to Harrisburg, 10 miles. Most of grading and bridges completed. Work to be resumed this spring.

GALESVILLE & ETRIC.—See Western Transportation Co.

GALVESTON TERMINAL.—See Colorado & Southern.

GARY, HOBART & VALPARAISO (Electric).—Proposed from Gary, Ind., via Hobert and Wheeler to Valparaiso, 20.5 miles. Grading to be started early this spring. Blake A. Mapledoram, Chief Engineer, Gary.

GENESEE RIVER.—See Erie.

GENESEE & ORLEANS (Electric).—Projected from Batavia, N. Y., north, via Albion, to the government harbor, Point Breeze, known as Oak Orchard, on Lake Ontaria, 27 miles. Grading will begin in April or May. Contracts not let. Geo. W. Mische, Rochester, N. Y., is interested.

GEORGIA & FLORIDA.—Projected connecting links aggregating 123 miles between existing lines to complete a through line from Augusta, Ga., via Keysville, Vidalia, Hazlehurst, Douglas, Nashville and Valdosta to Madison, Fla. North of Hazlehurst 8 miles is completed and the line to the Altamaha river. Contract let to M. M. Elkan, contractor, Vidalia, Ga., for entire 28.4 miles to Vidalia. About 26 miles from Keysville, Ga., to Augusta yet remain to be built.

GEORGIA ROAD (Electric).—Projected from Columbus, Ga., via Society Hill and Tuskegee to Montgomery. J. W. Mayberry, President, Society Hill.

GEORGIA, SOUTHWESTERN & GULF.—Projected from Albany, Ga., southwest via Colquitt and Donaldsonville and Marianna, Fla., to St. Andrews on the Gulf of Mexico, 160 miles. The entire line is under contract and grading will begin in the coming spring. Work includes a 500-ft. draw-span bridge over the Chattahoochie river. T. H. Hazelrigg, Chief Engineer, Indianapolis, Ind.

GILA VALLEY, GLOBE & NORTHERN.—See Southern Pacific.

GILMORE & PITTSBURGH.—Projected from Armstead, Mont., west to Salmon, Idaho. Surveys made and contracts let for grading, track laying and bridges. Work includes a 750-ft. tunnel. T. H. Bacon, Chief Engineer, Machesney building, Pittsburgh, Pa.

GLENRAY & RICHWOOD.—Projected from Alderson, in Monrie county, W. Va., north to Richwood, 40 miles, where connection is to be made with the Baltimore & Ohio. Surveys made and part of the rights of way secured. Construction work will be started early this spring. F. M. Arnold, director.

GOOSE LAKE SOUTHERN.—See Southern Pacific.

GOULD SOUTHWESTERN.—Projected from Douglas, Ark., east via Isom, Star City, Glendale, Calmer, Toledo, Rison, Croak, Bleeker and Bunn to Princeton, 104 miles. In operation from Isom to Star City, 21 miles. Rights of way for rest of line secured.

GRAND RAPIDS & NORTHWESTERN.—Projected from Grand Rapids, Mich., northwest to Ludington. Contract for first 20 miles from Ludington let to John Doyle, contractor, Grand Rapids. Eight miles completed near Wiley. Marshall F. Butters, President, Ludington.

GREAT NORTHERN.—Extension of the Vancouver, Victoria & Eastern from Keremeos, B. C., west to Princeton, 45 miles, under construction. J. H. Stewart, of Grand Forks, B. C., has grading contract for 40 miles, and F. P. Howard, of Maroon Valley, B. C., for work near Hedley. Projected from Princeton west to Abbotsford, where connection will be made with lines in operation.
——Extension under construction from Nashwauk, Minn., to Coleraine, about 16.5 miles.
——About 60 miles under construction on the Moses Coulee branch in Douglas county. Branch runs midway between the Columbia river and the Northern Pacific.
——Branch projected from Dewey Lake, Minn., north to International Falls, 78 miles of which is partially graded.
——Branch projected from Wenatchee, Wash., north to Oroville, 140 miles, which is partially graded.
——Branch projected from Wenatchee, southeast to Pasco, about 150 miles.
——See Spokane, Portland & Seattle, formerly Portland & Seattle.

GREENVILLE & KNOXVILLE.—Extension projected from Marietta northeast, via Cleveland, Riverview and River Falls to North Carolina state line, about 35 miles.

GULF & MAGNOLIA.—Projected from Hope, via Shover Springs, Bodcaw, Stockton and Waldo to Magnolia, 38 miles. Surveys made. Contracts to be let in near future. S. Q. Sevier, General Manager, Hope, Ark.

GULF, COLORADO & SANTA FE.—The Texas & Gulf is building from Center, Tex., via Tenaha to Zuber, 21.3 miles. John Scott & Sons, contractors, St. Louis, Mo., Work now in progress and will probably be completed in June, 1909.
——Work of reballasting the Beaumont division from Rayburn, Tex., east 16 miles, by the company's forces, is in progress.

GULF, TEXAS & WESTERN.—Projected from Burrs Ferry, Tex., on the Sabine river in Newton county northwest, via Henderson, Tyler, Canton, Kaufman or Terrell, Dallas, Jacksboro, Olney, Seymour and Vera, to Benjamin, on the Kansas City & Mexico, in Knox county, about 500 miles. There will also be a branch through Ft. Worth. Some 200 miles of right of way secured west of Dallas, 60 miles of which are graded. Construction work under way from Jacksboro west, about 200 miles. B. B. Cain, Vice-President, Tyler, Tex.

H

HANCOCK & EAST BRANCH.—See Delaware & Eastern.

HARRISVILLE & CORNWALLIS.—Projected from Harrisville, W. Va., to Cornwallis, 6¼ miles. Four and one-half miles graded. The work includes two steel bridges. A. Wolverton, Chief Engineer, Philippi, W. Va.

HILLSBORO & NORTHEASTERN.—Extension projected from Hillsboro, Wis., south to Richland Center, 28 miles.

HOLSTON RIVER RAILWAY.—See Virginia & Southwestern.

HOUSTON & BRAZOS VALLEY.—Contract given to I. T. Austin, of Velasco, Tex., for extension from Velasco to Quitman, 3 miles.

HUDSON & MANHATTAN.—Line under Sixth avenue, New York, being extended from Twenty-third to Thirty-third street.
——Branch to be built from Sixth avenue, New York, under Ninth street, to connect with the subway at Fourth avenue.
——Double-tube tunnel being built from Hoboken, N. J., in a southerly direction through the Erie and Pennsylvania stations in Jersey City, N. J.
——Extensions to be built from the Pennsylvania station in Jersey City to a connection with the present Pennsylvania main line.

HUNTINGTON RAILROAD (Electric).—See Long Island.

I

IDAHO RAILWAY & NAVIGATION.—Projected from Lewiston, Idaho, to the upper Snake river country. The company will also operate a line of small steamers on the upper Snake river to handle freight and passenger business, pending the completion of the road and to serve the construction camps. Grading under way. L. S. McDonald, Chief Engineer, Spokane, Wash.

IDAHO & WASHINGTON NORTHERN.—Work under way on the extension of this road from Newport, Wash., north along the west bank of the Pend O'Reille river to Ione, 52 miles. Grant, Smith & Co., contractors. Spokane. Surveys made from Ione north to Metaline, 8 miles.

ILLINOIS TRACTION.—Work under way on extension into St. Louis, Mo., which includes a bridge over the Mississippi river from the foot of Salisbury street, St. Louis to Venice, Ill. Company expects to be using its own bridge and terminals in St. Louis before the end of 1909; the improvements, including a passenger station, freight house and the bridge, to cost about $5,000,000. Plans are complete for extensions on the north, one of 47 miles and the other 30 miles, to complete a continuous interurban line from St. Louis northeast to Chicago.

INDIANAPOLIS, CLOVERDALE & TERRE HAUTE TRACTION.—Projected from Indianapolis, Ind., southwest via West Newton, Mooresville, Gasburg, Monrovia, Cloverdale and Brazil to Terre Haute.
——Bids asked for building branch from Mooresville, Ind., northwest to Roachdale, about 26 miles. E. M. Bowman, Director, Indianapolis, Ind.

INDIANAPOLIS, LOGANSPORT & CHICAGO.—Projected from Logansport, Ind., south to Indianapolis, 66 miles. Surveys made and rights of way secured. Graded for 2.5 miles at Indianapolis. W. A. Osmer, Ch. Engr., Logansport, Ind.

INDIAN CREEK VALLEY.—Construction work on 10-mile extension from Roger Mills, Pa., north to Jones Mills to be started at an early date. Location surveys from Jones Mills to Ligonier, 16 miles, completed. S. M. Faust, Ch. Engr., Connellsville, Pa.

INTERBOROUGH RAPID TRANSIT.—Projected extension from Flatbush avenue and Fulton street, Brooklyn, N. Y., along Flatbush avenue extension to the Manhattan bridge now under way. The Interborough offers to do the necessary construction for $1,200,000 and to operate the line under lease. The route of the proposed subway in Brooklyn is identical with a part of the Fourth avenue subway, for the construction of which the Public Service Commission has just let contracts; and the proposition of the Interborough seems to have been made on the assumption that these contracts will not be carried out for the reason that the city is not at present in a position to provide the necessary money.
——Work under way on additional subway tracks north from 96th street and Broadway to 102d street.

INTER-CALIFORNIA.—See Southern Pacific.

IOWA & OMAHA SHORT LINE.—Proposed from Omaha, Neb., via Oakland, Air Line, Guthrie Center to Des Moines, Iowa, 130 miles. Preliminary surveys made. Grading to begin at an early date. Contract let to G. W. Adams & Co., Walnut, Iowa, for 15-mile section between Council Bluffs, Iowa and Treynor. J. H. Mayne, Ch. Engr., Walnut.

J

JOLIET & SOUTHERN TRACTION.—Projected from Joliet, Ill., east, via New Lenox, Frankfort and Mattison to Chicago Heights, 26 miles. Grading completed and track laid from Joliet to Frankfort, 14 miles, and from Mattison to Chicago Heights, 4 miles. Fisher Construction Co., contractors.
——Extension projected from Chicago Heights to Hammond, Ind., 14 miles. No work done.
——Expect to build Bloomington, Pontiac & Joliet (electric) from Joliet south, via Wilmington, to Dwight during present year.
——Expect to build line from Pontiac to Chenoa this year.

JOPLIN & PITTSBURG (Electric).—General contract let to A. L. Register & Co., of Philadelphia, Pa., for extension from Pittsburg, Kan., southeast to Joplin, Mo., 25 miles. H. F. Coleman, Ch. Engr., Joplin.

K

KANSAS CITY, MEXICO & ORIENT.—Building from Kansas City, Mo., southeast via Wichita, Kans.; Fairview, Okla.; Chillicothe, Tex., Sweetwater and Presidio; Chihuahua, Mex., Minaca and El Fuerte to Topolobampo, on the Pacific coast in the state of Sinaola, 1,659 miles. In operation for 795 miles. Track laid in Kansas, 74 miles; Oklahoma, 199 miles; Texas, 172 miles; Mexico, 442 miles, a total of 887 miles, leaving 772 still to be built. Work is under way in the United States between Emporia, Kans., and Eldorado; between Sweetwater, Tex., and San Angelo. In Mexico, on the Chihuahua division, between the Rio Grande river and Folanier; on the western slope of the Sierra Madre mountains west of Sanchez and east of Hornillos on the Pacific coast division.
——The Kansas City Outer Belt & Electric, which will furnish the entrance into and terminal facilities at Kansas, Mo., the K. C. M. & O. building double-track line. Bridge over Missouri river not yet built.
——Branch projected from San Angelo, Tex., south to Del Rio, 180 miles.

KANSAS CITY, MEXICO & ORIENT.—See this company under United States.

KANSAS CITY, OZARKS & SOUTHERN (Electric).—Projected from Mansfield, Mo., southeast to Ada, 14 miles. Grading completed and part of track laid. Ozark Construction Co., contractors, Mansfield. Electricity is to be generated by water power on the Bryant river. J. B. Quigley, Ch. Engr., Mansfield.

KANSAS CITY OUTER BELT & ELECTRIC.—See Kansas City, Mexico & Orient.

KANSAS CITY, PARIS & GULF.—See Quitman & Great Northern.

KANSAS CITY SOUTHERN.—Grading on cut-off south of Howe, Okla., completed to Heooner. Bridging and track laying postponed.

KANSAS CITY TERMINAL CO.—Company incorporated to build new passenger station for railways entering Kansas City, Mo. Work will include a number of yards and retaining walls, highway and railway viaducts. John V. Hanna, Ch. Engr., Kansas City, Mo.

KANSAS-COLORADO (Electric).—Projected, in conjunction with the Colorado Transportation Co., from Garden City, Kans., via La Junto, Colo., Rocky Ford, Pueblo, Canon City and Colorado Springs to Denver. Surveys made from Garden City to Canon City. Contracts for grading and bridging for this section given to Northern Electric Co. A. H. Atwater, Director, Canon City. The Colorado Transportation Co. is also capitalized at $5,000,000, and has the same directors as has the K.-C.

KANSAS SOUTHERN & GULF.—Projected extension from Westmoreland, Kan., to Manhattan, 22 miles, including a 300-ft. bridge over the Blue river. Surveys made.
——Projected extension from Blaine, Kans., to Falls City, Neb., 65 miles. Surveys made.

KENTUCKY & OHIO RIVER (Electric).—Contracts for building part of the line from East Cairo, Ill., east to Paducah, Ky., 38 miles, let to Simms Bros., contractors, Thebes, Ill., for $70,113. Contracts let to Forbush & Stotlar, contractors, Benton, Ill., for building the 18 bridges on the line.

KENTUCKY MIDLAND.—Surveys made for extension from Midland to Madisonville, 13 miles.

KEWEENAW CENTRAL.—Surveys made for branch from Mandan, Mich., to Fish Cove, 12 miles.

KNOXVILLE, SEVIERVILLE & EASTERN.—Projected from Knoxville, Tenn., southeast to Sevierville, 26 miles. W. J. Oliver & Co., contractors. W. A. Seymour, Ch. Engr.

KOKOMO WESTERN TRACTION.—Projected line to be operated by gasolene motor cars, from Kokomo, Ind., west to Young America, 17 miles. Surveys completed and contracts for construction to be let soon. C. C. McFann, President and General Manager, Kokomo.

L

LAKE CHARLES RAILWAY & NAVIGATION.—Projected extension from Edna, La., to Kinder, 5 miles. Work under way. Where connection will be made with the Colorado Southern, New Orleans & Pacific.

LAKE ERIE & PITTSBURG.—See Lake Shore & Michigan Southern.

LAKE ERIE & YOUNGSTOWN (Electric).—Projected from Conneaut, Ohio, south to Youngstown, about 60 miles. Right of way partly secured. J. H. Ruhman, of Youngstown is interested.

LAKE SHORE & MICHIGAN SOUTHERN.—The Franklin & Clearfield has been building through Pennsylvania during the past two years. As projected the line is to run from Franklin, Penn., southeast to Brookville, 62 miles, thence east to Clearfield, a total of 110 miles. The eastern end of the line, from two miles west of Brookville to Clearfield, has not been finally located. The western end is finished from Franklin to Welch Run, 53 miles, and work is well advanced on the 7 miles from the river to two miles west of Brookville. The line is being built to secure a low grade route through the mountainous country bordering the Allegheny river, thence to the summit of the Alleghenies. There is to be one tunnel of 2,100 ft. and another of 1,700 ft. The extension to Clearfield will necessitate piercing a tunnel 2,500 ft. long. It is thought that the line will be in operation within a year. This will be made possible by traffic arrangements between Brookville and Clearfield. It is understood that such negotiations are under way with the Pennsylvania and the Buffalo, Rochester & Pittsburgh. In the event of such agreements it would only be necessary to build from Dubois to Clearfield.
——Contract let in 1907 by the Lake Erie & Pittsburgh to the Carter Construction Co., Indianapolis, Ind., to build from Mill Creek Junction, near Cleveland, southeast to Ravenna, 32 miles. Grading and bridge construction finished this year. Track laying under way and completed to Tinkers Creek, 7 miles. The line from Mill Creek Junction, which will connect with the Pennsylvania west of Ravenna, will probably be ready for operation this fall.

LAKE SUPERIOR & ISHPEMING.—Work on change of main line through Negaunee, Mich., about 3 miles; also for reducing the grade on a 5-mile branch and to extend this branch 3 miles completed and will probably be opened for traffic this summer.

LARAMIE, HAHN'S PEAK & PACIFIC.—Work under way on extension from the present end of track at Albany, Wyo., south to Summit, Colo., 15 miles. Bradbury & Dittmer, contractors. Extension is projected south from Summit to Coal Bank, Colo., an additional 55 miles.

LAWTON, WICHITA FALLS & NORTHWESTERN.—Projected from Red River junction, where connection will be made with the Wichita Falls & Northwestern, north via Randlett and Emerson, to Lawton, 40 miles. Intention is to have section from Randlett to Lawton, 34 miles, in operation by November, 1909. J. E. Kirk Cons. Co., contractor, Oklahoma City, Oklahoma. J. M. Bellamy, President, Lawton. A. J. Robinson, Ch. Engr., Frederick, Oklahoma.

LIVE OAK, PERRY & GULF.—Work under way on extension from Hampton Springs west to St. Marks, 30 miles. H. E. Warwick, contractor, Hampton Springs, Fla.

LONG ISLAND.—Work started in 1907 on Huntington Railroad (electric) from Huntington, N. Y., south to Amityville, 15.75 miles. Includes three bridges. Track laid on 7 miles. Surveys on the Babylon extension (electric) from Babylon west to Amityville, 5.82 miles. Jamaica & South Shore branch from Springfield Junction south to Cedarhurst, 3½ miles. All of this work suspended.
——Work under way to eliminate grade crossings at Old West road, Westbury, and New York avenue, Huntington.
——See Pennsylvania.

LOOP & LOOKOUT.—See Sewall Valley.

LOUISIANA & PINE BLUFF.—Contracts let to S. R. Neel, of Huttig, Ark., for extension from Dollar Junction, Ark., to New London, 15 miles. Further extension projected from New London to Wilmington, 15 miles. Work on these extensions postponed.

LOUISVILLE & NASHVILLE.—The Madisonville, Hartford & Eastern, projected from Madisonville, Ky., via Anton, Millport, Sacramento, Moorman, Centertown, Hartford and Dundee, to Mitchell, 55.6 miles, is about four-fifths completed. Contract let to C. G. Kershaw, contractor, Talladega, Ala., for 5 miles from Madisonville to Anton; to W. B. Sproule & Co., contractors, Dundee, for 8 miles from Pond river to Black lake, and to Edington; Griffitts Construction Co., contractors, Knoxville, Tenn., for 5 miles from Black lake to Green river. Track laid for 2 miles west of Madisonville. The masonry work of all the important bridges is completed and the steel work on hand. G. W. Feagin, Ch. Engr., Hartford, Ky.
——See Atlanta, Birmingham & Atlantic.

M

MADISONVILLE, HARTFORD & EASTERN.—See Louisville & Nashville.

MANISTEE & NORTH-EASTERN.—Projected extension of eastern branch from Wexford, Mich., northeast toward Alpena, 18

MARSHALL & EAST TEXAS.—Formerly the Texas Southern, operating from Winnsboro, Tex., on the M. K. & T., southeast to Marshall, on the T. & P., 74 miles. Projected extension from Marshall, south to Walker, 20 miles. Contract for first 12 miles of grading let to John Scott & Sons, contractors. Surveys being made for the second section.

MEMPHIS, PARIS & GULF.—Projected from Memphis, Tenn., via Little Rock, Ark., to Paris, Tex., 400 miles. In operation from Nalumco, Ark., southwest to Ashdower, 26.90 miles. Surveys made from Nalumco, northeast to Murfreesboro, about 15 miles.

METO VALLEY RAILROAD.—Projected from McCreanor, Ark., on the C. R. I. & P. south, through Lonoke county, about 16 miles. Work will include one bridge. S. M. Savage, President, Lonoke, Ark.

METROPOLITAN SOUTHERN.—See Baltimore & Ohio.

MILWAUKEE WESTERN ELECTRIC.—Projected from Milwaukee, Wis., northeast via Pewaukee, Oconomowoc, Neosho, Hutisford and Juneau to Beaver Dam. Contracts for bridging, track-laying, bridges, etc., will be let this spring. C. A. Chapman, Chief Engineer, Marquett building, Chicago.

MINIDOKA & SOUTHWESTERN.—See Oregon Short Line.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE.—Work under way by Foley, Welch & Stewart, St. Paul, on extension from Brooten, Minn., northeast to Duluth, 189 miles. In operation to Onamia, 86.5 miles.

MISSOURI, ARKANSAS & SOUTHWESTERN.—Projected from Batesville, Ark., northeast to Black Rock, 40 miles. R. W. Earnhart, President, Batesville.

MISSOURI, OKLAHOMA & GULF.—Building extension from Wagoner, Okla., north to Joplin, Mo., 120 miles, and another from Lamar, Okla., south to Denison, Tex., 114 miles.

MISSOURI SOUTHERN.—Extension projected from Bunker, Mo., northwest to Salem, 28 miles.

MONROE, FARMERSVILLE & HOPE.—Projected from Monroe, La., to Hope, Ark. Surveys made. D. H. Nichols, P. O. Box 509, Monroe, La.

MONTANA ROAD (Electric).—Projected line from Conrad, where connection is to be made with the Great Northern to Valier, 27 miles. Grading to be started this spring or summer. M. S. Darling, Conrad.

MORGAN'S LOUISIANA & TEXAS.—See Southern Pacific.

N

NASHVILLE & HUNTSVILLE (Electric).—Projected from Nashville, Tenn., south to Huntsville, Ala., 105 miles. T. W. Pratt, V.-Pres., Huntsville, Ala. I. L. McCord, contractor, Huntsville.

NASHVILLE & NORTHEASTERN.—See Cumberland River & Nashville.

NATCHEZ, COLUMBIA & MOBILE.—Projected extension from near Loweton, Miss., east to Pearl river, 3.5 miles. Surveys made.

NEBRASKA, KANSAS & SOUTHERN.—Projected from Stockton, Kans., via Ransom and Ness City to Garden City, 162 miles. Contract let to Kansas Railway Construction Co., Kansas City, Mo. Grading completed from section 5 to section 12, 7 miles. B. L. Brown, Ch. Engr., St. Louis, Mo.

NEBRASKA TRACTION & POWER CO.—Projected from Omaha, Neb., via South Omaha and Ralston to Papillion, 12 miles. About 75 per cent. of grading completed. General Construction Co., contractors, Omaha, Neb. W. D. Crist, Gen. Mgr., Omaha.

NEVADA & CALIFORNIA.—See Southern Pacific.

NEVADA-CALIFORNIA-OREGON.—Projected extension from Alturos north to Lakeview, Ore., 60 miles.

NEW ORLEANS GREAT NORTHERN.—Projected extension from Monticello, Miss., north to Jackson.

NEW YORK CENTRAL & HUDSON RIVER.—Work under way by company's men on Grand Central terminal in New York. Steel work being erected by Terry & Tench.

——Buffalo grade crossing elimination work in progress. Contract let to the Eyre-Shoemaker Co., Inc., contractors, Philadelphia, Pa.

——Work on large yard at Gardenville, near Buffalo, N. Y., temporarily suspended; 27 miles of track laid.

——Tracks in Tenth and Eleventh avenues, New York, to be removed from the surface. Not yet determined whether they will be elevated or depressed in a subway.

——Elimination of grade crossings on Harlem division in Mount Vernon, N. Y., in progress.

——Proposed elimination of grade crossings on Hudson division through Yonkers, Tarrytown and Ossining, N. Y. Necessary before electrification can be extended to South Croton. Some work done, but now suspended, awaiting action of New York Public Service Commission.

——Proposed elimination of grade crossings on Harlem division at Tuckahoe, N. Y. Plans being considered by village authorities.

——Proposed improvements at Oswego, N. Y., to cost $150,000.

NEW YORK CONNECTING.—See Pennsylvania.

NEW YORK, PHILADELPHIA & NORFOLK.—See Pennsylvania.

NEW YORK, PITTSBURG & CHICAGO AIR LINE.—Projected from Pittsburg, Pa., east via Indiana, Cherry Tree, Irvona, Sandy Ridge, Loveville, Tusseyville, New Berlin, Sunbury, Mahanoy City and Tamaqua to Allentown, 298 miles. Surveys made. Expected that construction work will begin this year. Joseph Ramsey, Jr., Orange, N. J., is interested. No connection with electric line projected under similar name.

NEW YORK SUBWAYS.—Work under way on a 4-track subway loop to connect the Brooklyn and Williamsburg bridges in the Borough of Manhattan. Contracts let on 5 sections, aggregating $9,094,606, as follows: Bradley Contracting Co., in Centre street between Pearl street and Park Row; Degnon Contracting Co., in Centre street between Pearl and Canal streets, including a spur from Centre street to the Manhattan bridge approach; Cranford Co., in Centre street between Canal and Broome streets; Bradley Contracting Co., in the new extension of Delancey street between Centre street and the Bowery; same company in Delancey street between Bowery and Norfolk street.

——The Public Service Commission, First district, has approved plans for the Broadway-Lexington avenue subway from the Battery at the south end of Manhattan Island, north under Church and Vesey streets to Broadway, thence under Broadway and Lexington avenue to the Bronx side of the Harlem river, where it will branch into two spurs, one to Woodlawn Cemetery and the other to Pelham Bay Park. The estimated cost of the work with a line across the island at Canal street, is $67,000,000.

——Contracts let for 6 sections of the Fourth avenue (Brooklyn) subway as follows: Nassau to Willoughby streets, Jas. P. Graham, $1,121,850; Willoughby street to Ashland place, William Bradley, $3,494,714; Ashland place to Sackett street, William Bradley, $3,600,227; Sackett street to 10th street, E. E. Smith Contracting Co., $2,490,205; 10th to 27th streets, Tidewater Building Co. and T. B. Bryson, $2,196,716; 27th to 43d streets, E. E. Smith Contracting Co., $2,982,648. Total, $15,886,360. Work on these contracts not yet authorized by the Board of Estimate and Apportionment.

NORFOLK & WESTERN.—Work in progress double-tracking line between Huger, W. Va., and Welch. Improvement includes a double-track tunnel at Welch. It is expected to have this work finished about July 1.

——The Interior & West Virginia, building from the terminus of the Big Stony Railway at the Virginia state line to connection with the Virginia & Potts Creek Railroad, 17.55 miles. Expected to have the line in operation by July.

——The Virginia & Potts Creek under construction from the end of the Interior & West Virginia Railroad to Paint Creek, Va. Grading finished on the 4.2 miles.

NORTHERN OF MAINE.—Projected from Van Buren, Me., west along the northern boundary of the state, via Grand Isle, Madawaska, Frenchville, Fort Kent and St. John to St. Francis, 62 miles. Edson E. Goodrich, Pres., and Henry F. Hill, Ch. Engr., Waterville, Me.

NORTHERN PACIFIC.—Projected extension from Mandon, N. Dak., northwest, along the Missouri river to Mondak, Mont., connecting with the Great Northern.

NORTH JERSEY RAPID TRANSIT.—Projected from Suffern, N. Y., south to Paterson, N. J., about 16 miles. W. A. Barbour, Pres.

NORTHWESTERN PACIFIC.—Surveys made for extension of main line from Willits, Cal., north to Shively, 108 miles; also for branch from the main line at Healdsburg northwest to Floodgate, 63 miles, where connection is to be made with branch from Albion, on the Pacific coast.

NORTHWESTERN RAILROAD.—See Oregon Short Line.

NORWOOD & ST. LAWRENCE.—Surveys made to build, under name of Raymondville & Waddington, an extension from the present northern terminus at Raymondville, N. Y., west to Waddington, 13 miles.

NUECES VALLEY, RIO GRANDE & MEXICO.—See Asherton & Gulf.

O

OCEAN SHORE (Electric).—Building double-track line from San Francisco, Cal., south to Santa Cruz, 78 miles. On main line grading 26 miles, in operation on 52 miles, also operating 2½ miles of branch line. The contractors are Lilly & Heins and Humboldt Contracting Co., of Santa Cruz; Graham-Nicholson Contracting & Engineering Co., of San Francisco, and Ransome-Crummey Co., of Oakland.

——The Ocean Shore & Eastern to build a branch from Santa Cruz, Cal., southeast to Watsonville, 19 miles. Surveyed. Nothing done in 1908.

——The San Juan Pacific to build from Watsonville, Cal., to Hollister, 25 miles. Surveyed. In operation for one-third of the distance. Nothing done in 1908.

——The San Joaquin Valley Western to build from Hollister, Cal., to Coalings, 200 miles. Surveyed. Nothing done in 1908.

OCEAN SHORE & EASTERN.—See Ocean Shore.

OCILLA SOUTHERN.—Contract given to R. S. Talmage, of Ocilla, Ga., to build from Ocilla south to Allapaha, 17 miles, thence to Nashville, 13 miles. J. A. J. Henderson, Ocilla, Ch. Engr.

OHIO NORTHERN & MICHIGAN (Electric).—Proposed lines to be built as follows: Toledo and Ann Arbor branch, to run north connecting Lambertville, Mich., Petersburg, Dundee, Milan and Ann Arbor; extension from Petersburg northwest to Jackson via Britton, Ridgeway, Tecumseh, Brooklyn and the chain of lakes south of Jackson. Graded from Petersburg to Ann Arbor, and track laid from Toledo, Ohio, north to Petersburg. The section from Petersburg to Jackson to be built at once. A. E. Lee, Pres., Vermillion, S. Dak. C. W. Steudell, Ch. Engr., 122 Monroe street, Chicago, Ill.

OKANOGAN ELECTRIC.—Proposed line from Nighthawk, Okanogan county, Wash., to the head of navigation on the Columbia river at the southern end of Okanogan county via Loomis, Okanogan, Ophir, Malott and Brewster, 80 miles; also branches to Coconully, Omak and Riverside. A. M. Dewey, Pres., and G. D. Needy, Sec., box 1864, Spokane, Wash.

OKLAHOMA & GOLDEN CITY.—Incorporated in Oklahoma, capital $12,000,000, to build from Pawhuska, Okla., northeast via Climax Springs, Mo., to Jefferson City; also branch from Climax Springs south to Springfield. Contracts for grading, track laying, etc., to be let in April. There will be five large bridges and some smaller ones, also some trestle work. W. S. Pope, Pres., Jefferson City; J. A. Griesel, Gen. Mgr., Golden City; E. M. Dempsey, V.-Pres., and W. S. Hawkins, Ch. Engr., Pawhuska, Okla.

OKLAHOMA ROADS.—The Miller Lumber Co., Millerton, Okla., is building a logging road from Millerton north, about 15 miles.

OREGON & WASHINGTON.—See Oregon Railroad & Navigation.

OREGON WESTERN.—See Southern Pacific.

OREGON EASTERN.—See Southern Pacific.

OREGON ELECTRIC.—Projected branches and laterals, aggregating 283 miles, as follows: Portland, Ore., to Tillamook; Portland to Eugene; Salem to Mill City; Salem to Dallas; Salem to Albany; and Albany to Cascadia. G. B. Moffat, Pres., New York, and G. W. Talbot, V.-P. and G. M., Portland.

OREGON RAILROAD & NAVIGATION.—The Oregon & Washington, projected from Portland, Ore., north to Tacoma and Seattle, Wash., 230 miles. At Tacoma there is to be a 8,700-ft. tunnel. Surveyed to Tacoma. Contract let to Twohy Bros., Spokane, Wash., for the first section. J. D. Farrell, V.-P. and G. M., Central building, Seattle.

OREGON SHORT LINE.—The Northwestern Railroad projected from Huntington, Ore., north along the Oregon-Idaho state line following the Snake river to Lewiston, Idaho. Grading and track laying under way by the Utah Construction Co., Ogden, Utah, from Blakes Spur north to Homestead, 58 miles; includes 2,200-ft. tunnel east of Huntington.

——Surveys under way for a line of about 120 miles from Twin Falls, Idaho, south to a connection with the Southern Pacific, about 20 miles east of Wells, Nev. The Minidoka & Southwestern has amended its charter to cover this survey. Construction not yet authorized.

——Surveys made for a line from Rupert, Idaho, northwest to Fuller. Construction not yet authorized.

——Grading work for double-track from Salt Lake City, Utah, north about 12 miles under way.

P

PALESTINE & DALLAS INTERURBAN.—Contracts to be let in May to build from Palestine, Tex., northwest to Dallas, 110 miles, with a branch from Waxahachie east to Ennis, 10 miles. J. V. Watkins, Pres. G. A. Duren, Ch. Engr., Corsicana, Tex.

PECOS & NORTHERN.—See Atchison, Topeka & Santa Fe.

PENHORN CREEK.—See Erie.

PENINSULAR RAILWAY (Electric).—Built from Bartow, Fla., west to Mulberry, 8 miles. Expects to begin work soon on remaining 37 miles to Tampa. Right of way secured. The Wm. H. Evers Engineering Co., in charge. W. H. Evers, Ch. Engr., Cleveland, Ohio.

PENNSYLVANIA & NEWARK.—See Pennsylvania.

PENNSYLVANIA.—Terminal improvements at New York being carried out by the Pennsylvania Tunnel & Terminal Railroad as follows:

——New line from Harrison, N. J., at a point east of Newark, where the tunnel line leaves the present main line, to the Weehawken shaft of the Hudson river tunnel. All of the masonry, outside of Bergen Hill tunnel and superstructure completed except the Hackensack river drawbridge superstructure, now under contract to the Pennsylvania Steel Co., of Steelton, Pa. Double track embankment nearly finished.

——Work on two single-track tunnels from Bergen Hill being carried on from both ends and from a shaft in the center. William Bradley & Sons, contractors. Excavation and concrete lining finished.

——Two single-track tube tunnels from Weehawken under Hudson river to 11th avenue shafts; tubes completed and concrete lining being put in. O'Rourke Engineering Construction Co., contractors.

——Western approach to passenger station between Ninth and Eleventh avenues. New York Contracting Co., contractors. All excavated and work from Ninth and Tenth avenues two-thirds finished.

——Contract for construction of the station building and all electrical equipment for the entire terminal and approaches let to Westinghouse, Church, Kerr & Co. Steel work under way on station building.

——Tunnels under 32d and 33d streets, Manhattan, from terminal station at Seventh avenue to East river. About one-half finished. United Engineering & Contracting Co., contractors.

——Four single-track tubes under the East river, from Manhattan shaft to Long Island completed except small amount of concrete. S. Pearson & Son, Ltd., contractors.

——Tube tunnels from river shaft east under Long Island city to East avenue shaft. Excavated, iron lined and concrete finished. S. Pearson & Son, Ltd., contractors.

——Tunneling under streets in Long Island City from East avenue shaft to western end of Sunnyside yard, near Thompson avenue; about two-thirds finished.

——Large terminal to be known as the Sunnyside yard, between Jackson and Thompson avenues, Long Island City. To be 5,500 ft. long, 1,550 ft. wide at widest point and include about 400 acres. Work on viaducts, embankments, and bridge masonry under way. Yard about 75 per cent. finished.

——Franchise granted to the Long Island Railroad for Glendale cut-off between Glendale Junction and Woodside, at the entrance to Sunnyside yard. The cut-off is to be a four-track line. All grade crossings between Jamaica and Woodside will be eliminated.

——Franchise granted the New York Connecting Railroad for line through Brooklyn and Queens boroughs, New York City, and over the East river on a bridge to connection with the New York, New Haven & Hartford at Port Morris on the Harlem river. New line to be built from Manhattan Junction, on Long Island Railroad, to the East river and bridge over the East river and Ward's and Randall's islands, with a connection at Long Island City to the Sunnyside yard. The line is to include on its south end through Brooklyn the Bay Ridge line of the Long Island Railroad from East New York to Bay Ridge, on which improvements are under way to eliminate 115 grade crossings, at a cost of about $7,000,000.

——Work to be started soon on large freight terminal at the Bay Ridge waterfront, Brooklyn. This is to be the western terminus of the New York Connecting Railroad, where cars will be put on boats to be sent to the Pennsylvania yard at Greenville, N. J. Contracts for piers and float bridges let. There is to be a pier 600 ft. long with four tracks. The yard will have a frontage on the upper bay of 565 ft., extending to Fifth avenue between 64th and 65th streets. About 40 tracks, with a capacity of 1,800 cars, are to be laid west of First avenue.

——Terminal yard at Pacific street, Brooklyn, N. Y. Work nearing completion.

——Track elevation begun on the Kensington branch in the northeastern part of Philadelphia. Contract let to the James McGraw Co.

——On the Monongahela division the Ten-Mile Run branch, from Ellsworth, Pa., to Millsboro, 15.5 miles, has been finished from Ellsworth south 8 miles, and from Millsboro north 1.6 miles.

——Improvement of grades and curvature between Jersey Shore, Pa., and McElhattan. Under way.

——Proposed relief freight line, to be built under the name of the Pennsylvania & Newark, from West Morrisville, Pa., to Newark, N. J., 50 miles. With its completion, the 6-track system will extend from Trenton to Jersey City. Includes new bridge across the Delaware river from Trenton, N. J., to Morrisville; nothing done in 1908.

——Plans to complete the 4-track system between New York and Pittsburgh, Pa., are now under consideration. It is proposed to make a cut in place of the present two-track main line tunnel near Greensburg, Pa. It will cost about $650,000 to cut out the tunnel, and widen for four tracks, put up a new passenger station, and underground and overhead crossings.

——Bids asked for widening the stone arch bridge over the Conemaugh river, just west of South Fork, on the Pittsburgh division, to hold four tracks instead of three as at present.

——The New York, Philadelphia & Norfolk is building 3 miles of second track between Keller, Va., and Olney. Arrangements being made to lay second track between Salisbury, Md., and Fruitland, about 4 miles.

PENNNSYLVANIA TUNNEL & TERMINAL RAILROAD.—See Pennsylvania.

PHILADELPHIA & READING.—Agreement made with the city of Philadelphia to elevate tracks. Much of the grade elimination work on the Philadelphia, Germantown & Norristown was let last year.

PHILIPPINE RAILWAY.—Work under way by the Philippine Railway Construction Co., which has let contract to J. G. White & Co., New York, to build 300 miles of road on the islands of Negros, Panay and Cebu, P. I. Grading under way on 33 miles in island of Panay, track laid on 40 miles in Panay, and 60 miles in Cebu. William Salomon, Chairman, and Charles M. Swift, Pres., New York.

PHILADELPHIA TERMINAL TRANSFER.—Projected from the Schuylkill river, between Manayunk and Norristown south, to Delaware river, adjacent to Philadelphia, Pa., at Fort Mifflin, 14.5 miles. E. B. Colket, President. H. A. Farrand, Ch. Engr., Philadelphia, Pa.

PITTSBURGH, BINGHAMTON & EASTERN.—Organized to build from Binghamton, N. Y., southwest to Clearfield, Pa., 232.5 miles. About 6 miles of track laid between Powell, Pa., and Canton, 20 miles graded, and some four bridges have been put up. Contract let to Wm. J. Oliver & Co., of Knoxville, Tenn., and sub-contract to Rivenac & Co. Louis T. McFadden, John P. Reynold, Jr., and Fred C. Leonard, Canton, Pa., Receivers, appointed in latter part of 1908.

PORTLAND & SEATTLE.—See Spokane, Portland & Seattle.

PORT O'CONNOR, RIO GRANDE & NORTHERN.—Projected from Port O'Connor, Tex., on the Gulf of Mexico, north to San Antonio, 190 miles, with a number of branch lines, including one to Gonzales, in all 234 miles. About 100 miles graded, but no track laid. Contract reported let to J. H. Collins, of Chicago. L. A. Gueringer, Ch. Engr., Victoria, Tex.

PRESCOTT, READER & FORDYCE.—Surveys being made from Lyda, Ark., west, to Prescott, 18 miles. One mile built last year.

Q

QUITMAN & GREAT NORTHERN.—Surveys being made from Paris, Tex., south to Minneola, 85 miles, thence under the name of Kansas City, Paris & Gulf, to Sabine Pass, 225 miles additional. Located from Quitman to Mineola. M. J. Healy, General Manager, Quitman, Tex.

R

RALEIGH & SOUTHPORT.—Projected extension from Fayetteville, N. C., southwest to Hope Mills, 5 miles.

RALEIGH & SOUTHWESTERN.—See Chesapeake & Ohio.

ROARING FORK.—Surveys for an extension from Roaring Fork, Va., to Big Black Mountain, 4.5 miles. E. L. Gobble, Chief Engineer, Blackwood, Va.

ROCHESTER, SYRACUSE & EASTERN.—See Syracuse, Lake Shore & Northern.

ROGUE RIVER & OREGON SOUTHERN (Electric).—Organized to build from Grant's Pass, Ore., southwest through the Rogue river valley to Waldo about 50 miles. Work to be begun this spring. O. S. Blanchard, of Grant's Pass, is interested.

ROME & OSCEOLA.—Organized to build from Rome, N. Y., north to Osceola, 25 miles. W. P. White, President, Utica, N. Y.

ROSCOE, SNYDER & PACIFIC.—Work is under way by Smith & Harrington, of Snyder, Tex., on 9 miles, J. W. Sammons on 3 miles and L. M. Kirkes 6 miles, on an extension from Snyder, Tex., northwest to Fluvanna, 20 miles. Grading on this extension to be finished March 20, and track-laying to be begun this summer. Chartered to build from Roscoe, Tex., north to Portales, N. Mex., 230 miles. Now in operation from Roscoe to Snyder, 30.4 miles.

ROYALTON & ELIZABETHTOWN STREET RAILWAY.—Grading to be begun April 1, from Middletown, Pa., southeast to Mount Joy, 15 miles, with a branch from Conewago northeast to Lebanon, 22 miles surveyed. Shops are to be put up at Elizabethtown. Office 1324 Real Estate Trust bldg., Philadelphia, Pa.

RUSTON, NATCHITOCHES & NORTHEASTERN.—Surveys have been made for a line from Ruston, La., north to Farmerville, 26 miles. J. H. Nolan, President, Ruston.

S

ST. LOUIS & ILLINOIS BELT.—Contract let last year to the J. A Ware Construction Co., 308 Houser building, St. Louis, Mo., for an extension from the present end of track to Edwardsville, Ill., 4 miles.

ST. LOUIS, BARTLESVILLE & PACIFIC.—Contract let last year for the construction work between Joplin, Mo., and Bartlesville, Okla. The entire survey covers about 300 miles. D. H. Rhodes, Ch. Engr., 213 Fourth street, Joplin, Mo.

ST. LOUIS, BROWNSVILLE & MEXICO.—Building a spur line from Buckeye, Tex., via the plant of the Tres Palacios Rice & Irrigation Co., finished for 9 miles. This spur may be developed and extended to form a 20-mile branch.

——Surveys made for an extension from Donna, Tex., to Sugar Mill, 2 miles.

ST. LOUIS, WEBSTER & VALLEY PARK (Electric).—Building from West End Heights, Mo., southwest to Valley Park, 15 miles. Chas. Schueler has contract for grading. Paul D. Cable, President and General Manager. 223 Wainwright building, St. Louis, Mo.

ST. MARY'S & KINGSLAND.—Work to be started soon by the company's men, on an extension from Kingsland, Ga., northwest to Waycross, 48 miles. A further extension west is projected from Waycross to Nashville, 50 miles.

ST. PAUL BRIDGE & TERMINAL RAILWAY.—Contract let to Wm. J. Hoy, of St. Paul, for substructure work, consisting of four concrete piers on pile foundation for steel bridge over the Mississippi river. The line is under construction from South St. Paul, Minn., to St. Paul yards at Dayton's Bluff, 2¾ miles. Pile and trestle approaches up to west bank of river finished and track laid to the river. Alfred Jackson, St. Paul, is Engineer in charge.

SACRAMENTO SOUTHERN.—See Southern Pacific.

SALEM, FALLS CITY & WESTERN.—Building from Dallas, Ore., to Salem, 14 miles. Work suspended during winter to be resumed April 1. It is expected that the extension will be finished by October. L. Gerlinger, President, Portland, Ore.

SALT LAKE & OGDEN.—Contracts let last year for an extension. It is expected that the road will have a total length of 100 miles by the end of 1909; also that the electrification of the line between Salt Lake City, Utah, and Ogden will be finished.

SAN ANTONIO & RIO GRANDE.—Contract let last year to the Hidalgo Construction Co. for building 25 miles of this line. The proposed route is from Brownsville, Tex., north to San Antonio, 300 miles. S. A. Robertson, Ch. Engr., San Benito, Tex.

SAN DIEGO, EL PASO & ST. LOUIS.—Incorporated in Texas to build the first section of 100 miles from El Paso, Tex., northeast to the New Mexico state line. Charter ready to file in New Mexico for next section about 200 miles to be built across southeastern New Mexico. Surveys now being made for the section in New Mexico. Rights of way and sites for terminals secured along almost the entire line. To be built to the Red river at the Texas-Oklahoma state line, a total of 500 miles. Three bridges. W. H. Winter, Secretary. P. A. McCarthy, Ch. Engr., El Paso.

SAN JOAQUIN VALLEY WESTERN.—See Ocean Shore.

SAN JUAN PACIFIC.—See Ocean Shore.

SANOODY VALLEY.—Contract let last December to J. B. Taylor & Co., Hudson Terminal building, New York, to build this line from DeKalb, Miss., to a connection with the Mobile & Ohio at Sucar-

nochee, Miss., 12 miles. J. P. Hornaday & Co., 30 Church street, New York are interested.

SANTA FE, LIBERAL & ENGLEWOOD.—Work under way at various points from Des Moines, N. Mex., east via Hooker to Woodward, Okla., a total of 321 miles. The Canadian River Railroad, building from Woodward, southeast to Watonga with a branch east to Guthrie and another branch southeast to Oklahoma City 220 miles, is to form part of this line. H. B. Peebles and A. H. Applegate, of Woodward; C. A. Barden, of Boston, Mass.; H. C. Morand, of New York, and F. L. Hamilton, incorporators.

——The Santa Fe, Raton & Des Moines has given a contract to the Nevada Construction Co., of Raton, N. Mex., for an extension from Capulen, N. Mex., southwest to Cunningham, 13 miles.

SANTA FE, RATON & DES MOINES.—See Santa Fe, Liberal & Englewood.

SAVANNAH, AUGUSTA & NORTHERN.—Organized to build from Savannah, Ga., northwest to Chattanooga, Tenn., with an easterly line to Augusta, in all about 425 miles. Surveys made from Statesboro to Chattanooga. Track laid on first 25 miles from Statesboro to Garfield. Graded from Garfield to Louisville, about 20 miles. Rights of way secured from Louisville to Commerce, about 100 miles. Wm. H. Lynn, Pres., New York; Hinton Booth, Secretary, Statesboro, Ga.

SAVANNAH VALLEY.—Contract reported let last year to J. W. Wright, Jr., to build this projected line from Garnett, Ga., south to Sylvania, 15 miles. E. T. Comer and L. J. Kilpatrick, both of Mill Haven, are directors.

SCHENECTADY & MARGARETSVILLE.—See Delaware & Eastern.

SEATTLE-EVERETT INTERURBAN.—Contract given by this company and the Everett Railway, Light & Water Co. to the Stone & Webster Engineering Corp., Boston, Mass., for a line from Halls Lake, Wash., to Everett, 13 miles.

SEWALL VALLEY.—Building from Meadow creek, W. Va., to the mouth of Sewell creek, 21 miles, about two-fifths graded. Work being done by the Morasco & Pasqualichis Co., on 2 miles, and company's men on 19 miles, to be finished in 1909. At the mouth of Sewell creek connection to be made with the Loop & Lookout Railroad, to be built along Meadow river, 25 miles, partly graded. J. M. Raine, Ch. Engr., Meadow Creek.

SHREVEPORT NORTHEASTERN.—Projected from Shreveport, La., northeast via Minden and Homer, La., and Eldorado, Ark., to Memphis, Tenn., 285 miles. Rights of way secured; also land for stations and terminal sites. Under construction from Shreveport to Homer, 50 miles; to be extended to Eldorado, 35 miles. Graded for 28 miles, and track laid for 8 miles. A. K. Clingman, Shreveport, La., President and General Manager.

SIOUX CITY & SPIRIT LAKE (Electric).—Contract let to Westinghouse, Church, Kerr & Co., to build from Sioux City, Ia., northeast to Spirit Lake, 108 miles. Work to be begun this spring. Frank Patch, Pres., and L. F. Wakefield, Ch. Engr. American Block, Sioux City.

SOUTHERN.—Second-track work under way on 3 miles between Motley, Va., and Galveston, expected to be finished by April.

——Similar work between Winesap, Va., and Durnald, including a line through the city of Lynchburg, 6.9 miles, is heavy and includes a 1,300-ft. tunnel. Work suspended, except on tunnel, to be finished in May.

——The Carolina & Tennessee Southern, projected from Bushnell, N. C., west along the northern bank of the Little Tennessee river to the North Carolina-Tennessee state line, 26 miles, is finished from Bushnell for 14.5 miles; and in operation on 13.9 miles; work suspended. From the state line further extension under the name of the Tennessee & Carolina Southern to Maryville, Tenn., 38.8 miles; on the latter grading has been finished for 37.4 miles. In operation on 25.3 miles; work suspended.

——About 132 miles of second track is now in operation between Washington and Atlanta, 650 miles; 32 miles more will be put in operation about May 1.

——The Memphis & Chattanooga projected from Chattanooga, Tenn., to Stevenson, Ala., 42 miles, grading and masonry from point near Chattanooga to east portal of Lookout mountain tunnel, about 90 per cent. finished. Work suspended. Work on the double-track tunnel through Lookout mountain, 3,500 ft. long, finished.

SOUTHERN PACIFIC.—Morgan's Louisiana & Texas is building an extension from Lafayette, La., northeast to Port Allen (opposite New Orleans), 53 miles, graded for 41 miles and track laid on 29 miles. Piers for the large bridge over the Atchafalaya swamp have been sunk and material for the superstructure is on the ground. Work under way east of the Atchafalaya river. Extension graded from Bayou Sale to South Bend and track laid on 7 miles.

——The Central California, building from Niles, Cal., to Redwood City, 16 miles. Graded for 14 miles and track laid on 12 miles.

——The Inter-California building an extension east from Calexico, Cal., through the nothern part of Mexico to Hanlon Junction, Ariz., 54 miles. In operation to Tecolote, Mex., 33 miles.

——The Oregon Eastern has finished surveys from Natron, Ore., south to Klamath Falls, 152 miles; also for a line from the Cascade mountains east to the eastern boundary of the State at Ontario. Charter amended to build a branch from Lakeview, Ore., south to the California state line, about 15 miles, an extension of this branch is projected south through California.

——Oregon Western projected 82 miles. Surveys made from Drain, Ore., via Marshfield to Ward and considerable right of way secured. Grading and tunneling under way and a large part of steel bridges, rails, ties and other track material bought; about 20 miles finished.

——The Nevada & California extension from Keeler, Cal., south to Mojave, 140 miles, track laid from Mojave on 52.80 miles, in operation on 48.3 miles. Work on the remaining 93 miles in progress.

——The Sacramento Southern, building from Sacramento Cal., south to Antioch, 54 miles, is graded for 10 miles and has track laid on 4.45 miles. Work is now in progress on the remainder of the line.

——The California Northeastern, building from Weed, Cal., north to Klamath Falls, Ore., 89 miles, is in operation from Weed to Holland, 74 miles. Work under way on remaining 15 miles to Klamath Falls.

——The Sunset Western, building from Pentland, Cal., northerly 14.86 miles; during 1908 laid track from Pentland, north, on 12.73 miles.

——Surveys made for extension of the Gila Valley, Globe & Northern, through Globe, Ariz., to Miami. No definite conclusion has been reached to build.

——Work under way on the remaining 10.17 miles of the Beaverton & Willsburg, a cut-off projected from Beaverton, Ore., east to Willsburg (Portland), 13.5 miles. Pacific Coast Construction Co., contractors, Portland, Ore.

——The Goose Lake & Southern, incorporated to build 406 miles of railway from Goose Lake, Cal., south to Alturas, from which point there are to be two branches, both continuing in a southwesterly direction to connections with the Southern Pacific at Vina and at Cottonwood.

——For Southern Pacific Railroad of Mexico and Cananea, Yaqui River & Pacific, see Southern Pacific under Mexico.

SOUTHERN UTAH.—Contract let to the Ely Construction Co., of Springville, from Mill creek coal mine, Utah, east to Price, 20 miles. Finished for 6 miles. J. F. Williamson, Price, Utah, Ch. Engr.

SPARTA RAILWAY & POWER CO.—See Western Transportation Co.

SPOKANE & INLAND EMPIRE (Electric).—The Spokane, Columbia & Western to build from Spokane, Wash., west to Davenport, thence northwest to Miles City, 73 miles. Surveys being made, and work under way on tunnel in Spokane.

SPOKANE, COLUMBIA & WESTERN (Electric).—See Spokane & Inland Empire.

SPOKANE, PORTLAND & SEATTLE.—This road, formerly the Portland & Seattle, is a joint project of the Northern Pacific and Great Northern, to give them a direct low-grade line to Portland, Ore. Building from Portland up the north bank of Columbia river and to Spokane, Wash., with branch east along the Snake river to Texas Ferry, Wash., a total of 415 miles. In operation from Vancouver, Wash., to Kennerwick, opposite Pasco, 221 miles; also from Vaucouver, south, to Portland, 10 miles. The line between Pasco and Spokane, 145 miles, is to be put in operation in April, and the branch to Texas Ferry, 41 miles, is to be finished in 1909.

STAMFORD & NORTHWESTERN.—A general contract has been given to P. M. Johnston, Son & Allhands, of St. Elmo, Ill., for grading, buildings, bridges, etc., and sub-contract let to J. L. McSpadden for the first five miles out of Stamford. The company plans to build from Stamford westerly to Dickens, 75 miles. All grading to be finished and several miles of track laid by July. L. M. Bule, President, and P. G. Burns, Ch. Engr., Stamford.

SUGAR CREEK & NORTHERN.—See Wheeling & Lake Erie.

SUNSET WESTERN.—See Southern Pacific.

SYRACUSE, LAKE SHORE & NORTHERN (Electric).—Extension from Fulton, N. Y., northwest to Oswego, about 20 miles, will probably be built in 1909.

——Extension of the Rochester, Syracuse & Eastern from Port Byron, N. Y., east to Syracuse, about 35 miles is to be built in 1909. Surveys made, franchises and rights of way secured. Contracts to be let in March.

T

TAMPA NORTHERN.—Projected extension from Brooksville, Fla., north to Dunnellon, 35 miles.

TENNESSEE & CAROLINA SOUTHERN.—See Southern.

TENNESSEE NORTHEASTERN.—Projected from Winfield, Tenn., southwest through Scott, Fentress, Cumberland and White counties, to the N. C. & St. L., near Ravenscroft, about 90 miles. D. L. Fickes, President, and P. C. Chesbrough, Treasurer, both of Scranton, Pa.

TENNESSEE RAILWAY.—Building from a point 2 miles below Smokey creek, Tenn., to Beech fork, on New river, 8½ miles; also spur along Smokey creek to Asher fork, 8½ miles. Track laid for 10 miles and in progress on remaining 7 miles.

TEXAS & GULF.—See Gulf, Colorado & Santa Fe.

TEXAS & NEW ORLEANS.—Grading about finished on Rusk branch, from Gallatin, Tex., to Rusk, 9 miles. Track laid from Gallatin on 2 miles. The Suderman-Dolson Co., Galveston, Tex., contractors.

TEXAS SOUTHEASTERN.—Projected extension to Crockett, and eventually to Waco. Surveyed.

TEXAS STATE.—Building from Rusk, Tex., west to Palestine, 30 miles. Nearing completion.

——Projected extension from Rusk, Tex., south 100 miles towards Houston.

THOMPSON RUN COAL & RAILROAD.—Projected extension of 6 miles; now in operation from Thompson Run Mines, Pa., to Ellwood Junction, 4 miles.

TOLEDO & MICHIGAN.—Considerable work is being done from Adrian, Mich., through Clayton, Hudson, Pittsford, Osseo, Hillsdale, Janesville, Quincy and Coldwater, about 60 miles. The roadbed is graded for 32 miles and a number of concrete culverts and bridges are built. P. T. Duket, President, Ohio building, Toledo, Ohio.

TOPEKA & NORTHWESTERN.—See Union Pacific.

TOPEKA-SOUTHWESTERN.—The Topeka Southwestern Construction Co., Topeka, Kan., building from Topeka, Kan., southwest to Council Grove, about 60 miles. V. R. Parkhurst, of Topeka, is Chief Engineer of the railway company.

TUSCARORA VALLEY.—Projected extension from the present southern terminus at Blair's Mills, Pa., southwest to McConnellsburg, 27 Miles surveyed.

TWIN CITY & LAKE SUPERIOR (Electric).—Building double-track third rail line from Minneapolis, Minn., via St. Paul and Superior, Wis., to Duluth, Minn., 130 miles. Contracts let to Westerdahl & Carlson to build from Lower St. Croix river to Upper St. Croix, 33 miles, and to Smith & James from Upper St. Croix to Superior, Wis., 60 miles. Track laid from Minneapolis to Coon lake, 25 miles. Contracts for 2 large bridges to be let about April 1. J. H. Thomas, Ch. Engr., 440 Railway building, Minneapolis, Minn.

U

UNION PACIFIC.—On the remaining 52.63 miles of the projected line from Hershey, Neb., to Northport, 51.17 miles are graded and ready for track laying. Work suspended.

——Contract let to the Kilpatrick Bros. & Collins Co., of Beatrice, Neb., for extension of Topeka & Northwestern from Onaga, Kans., northwest to Marysville, 32.44 miles, graded for 13.13 miles.

——Building two small branch lines east of Greeley, Colo., about 25 or 30 miles; also branch from Denver to a connection with the Boulder branch near Erie, about 18 miles.

UNION TERMINAL RAILWAY.—(St. Joseph, Mo.).—This company connecting all lines entering St. Joseph, proposes to lay two miles of additional tracks in St. Joseph.

UNITAH RAILROAD.—Surveys for an extension from Dragon, Utah, northwest to Randlett, 65 miles. E. A. Grove, Superintendent, Mack, Colo.

V

VALLEY RIVER.—Building from Mill Creek, W. Va., south to Clover Lick, 44 miles; graded from Mill Creek south to Elkwater, 7 miles. John M. Alden, Ch. Engr., Elkins, W. Va.

VANDALIA.—Second-track work in Indiana between the Wabash river bridge, Terre Haute and Macksville will probably be finished this summer.

VINEGAR BEND LUMBER CO.—See Alabama & Mississippi.

VIRGINIA & CAROLINA SOUTHERN.—Building extension from St. Pauls, N. C., north to Hope Mills, 12 miles.

VIRGINIA & SOUTHWESTERN.—Contract let to Callahan Construction Co., of Knoxville, Tenn., for extension from Moccasin Gap, Va., south to the Tennessee state line, 6 miles, thence under the name of the Holston River Railway, southwest to Persia, Tenn., 38 miles. All grading and structures 80 per cent. finished. Additional contracts to be let soon. It is expected that the line will be ready for operation by October, 1909.

VIRGINIAN RAILWAY.—Contracts let to T. Towles & Co., Mullens, W. Va.; W. O. Lipscomb, Roanoke, Va.; J. C. Carpenter & Co., Clifton Forge, Va.; Mason & Hanger Co., Richmond, Ky., for the Winding Gulf branch, between Mullens, W. Va., and Pemberton, about 25 miles. Expected that track-laying will begin in April and the branch to Pemberton completed by November.

W

WABASH-PITTSBURGH TERMINAL.—Work under way replacing old timber trestles with steel bridges and viaducts, on concrete masonry, and with concrete arches and embankments. About 75 steel bridges are to be repainted. The lining of two tunnels with concrete is being done by the company's forces and 5 more will be finished in 1909. Contracts for lining 7 additional tunnels have been let.

WASHINGTON & WESTERN MARYLAND.—See Baltimore & Ohio.

WASIOTA & BLACK MOUNTAIN.—Contract let to T. J. Asher & Sons, of Wasiota, Ky., to build from Mill Rice, Ky., north to Toms creek coal fields. Track laid on 3½ miles. T. J. Asher, President; A. B. Gloster, Ch. Engr., Middesboro, Ky.

WEAVERVILLE ELECTRIC CO.—Contract let to the Asheville Dray, Fuel & Con. Co. to build from Asheville, N. C., northwest to Weaverville, 8 miles. Track laid for 1 mile.

WESTERN & ATLANTIC.—A commission has been appointed by the State of Georgia to investigate the practicability of extending this road from Atlanta to the Atlantic seacoast.

WESTERN PACIFIC.—Building from Salt Lake City, Utah, west to Oakland, Cal., 923.7 miles, from which point a ferry service will be used to San Francisco, 3.5 miles. Of this, 121.5 miles will be in Utah, 427.3 miles in Nevada and 378.4 miles in California. Contracts let to the Utah Construction Co., Ogden; E. B. & A. L. Stone, Oakland, Cal., and Maney Bros. & Co., Winnemucca, Nev., for building the line. Up to January 1, 1909, grading on the main line was finished on 745 miles, and track laid on 489 miles. There will be a total of 43 tunnels, aggregating 45,527 ft., which are about 89 per cent. finished, and there are to be 40 steel bridges aggregating 9,261 ft., of which 22 are finished, aggregating 4,985 ft. The company has also completed a telegraph line for 356 miles. The terminal ferry slip improvements at Oakland Mole are finished except the house. Stations have been finished from Salt Lake City, Utah, to Shafter, Nev., and eleven are under construction in California. Division terminals are in process of construction at Wendover, Utah; Elko, Nev., and Stockton, Cal. Regular trains are now in operation from Salt Lake City, west to Shafter, Nev., 161 miles, which will probably be extended to Elko, Nev., 261 miles early in March. It is expected to have the entire main line, which will have a maximum grade of one per cent., finished by September, 1909.

WESTERN RAILWAYS & LIGHT CO.—The Chicago, Ottawa & Peoria, organized to build an electric line from Peoria, Ill., north, and thence east to Chicago, about 175 miles, is in operation from Princeton, Ill., east to Seneca, 58 miles. Work started on a branch from Ottawa south to Streator, 16 miles.

WESTERN TRANSPORTATION CO.—Surveys made and rights of way secured on 30 miles from Portage, Wis., north via Briggsville, Oxford, Friendship and Arkdale to Grand Rapids, about 70 miles.

——Negotiations finished to take over the Sparta Ry. & Power Co., organized to build from Sparta, Wis., northwest via Angelo, Trout Falls and Cataract to Melrose, 28 miles. Contracts let to local parties to build the entire line. Contracts to be let soon for bridges, including one 800 ft. long, with approaches. Shops and car barns are to be built at Sparta.

——The Galesville & Etric, which had projected a line in Wisconsin, will be built in 1909 by the W. T. Co., as well as a 60-mile interurban electric line in Montana. C. Oehler, Ch. Engr., St. Paul, Minn.

WHEELING & LAKE ERIE.—Work on the Sugar Creek & Northern.

——Building a low grade cut-off line from Bolivar, Ohio northwest to Orrville, 22 miles under way, and is expected to be ready for operation about May 1. The 1,800-car yard, roundhouse, coaling tipple and shop buildings at Brewster, Ohio, will be completed later.

——Extending 90-lb. rails from Middle Branch, Ohio, on the Cleveland division to a connection with the Sugar Creek & Northern, 21 miles.

WICHITA FALLS ROUTE.—Preliminary surveys being made by the Wichita Falls & Northwestern, from Frederick, Okla., northwest. Route not yet decided. Surveys made for extensions from Frederick, west, via Olustee and Duke, to crossing of fork of Red river north of Duke.

——Projected extension of the Wichita Falls & Southern, from New Castle, Tex., south to Llano, about 200 miles. Nothing done. Track laid last year on 12½ miles to New Castle. Plans are under consideration to continue the extension south 50 miles to the Texas & Pacific at Cisco, Tex.

WILLIAMSPORT & NORTH BRANCH.—Surveys made for an extension from Bernice, Pa., to coal mines in the Bernice district, about four miles.

CANADA.

ALBERTA CENTRAL.—Subsidy granted to build from Red Deer, Alb., west to the Rocky mountains, 70 miles. Further extension projected from near Rocky Mountain House, Alb., to the Grand Trunk Pacific near Yellow head Pass, and from Battle river to Saskatoon, Sask., or Warman; also from east of Red Deer, Alb., southeasterly to Moose Jaw. Smith & Johnston, solicitors, Ottawa, Ont.

ALGOMA CENTRAL & HUDSON BAY.—Building extension from present end of track mile 69.35, at the Chippewa river, Ont., north to mile 170; mile 173 to mile 233, with branch from mile 163 to Missanable on the Canadian Pacific, in all 190 miles.

——Projected extension of branch from Missanable to James Bay, 314 miles.

——The Manitoulin & North Shore building extension from mile 13 to mile 25.5; also from Little Current to Stanley on the Canadian Pacific and from mile 29.35 to mile 35, in all 51.65 miles.

——Projected branch of the Manitoulin & North Shore from Gertrude to Searchmont on the A. C. & H. B., 160 miles.

ATLANTIC, QUEBEC & WESTERN.—Work under way on 62 miles in Quebec between Pabos and Gaspe by the New Canadian Co., Ltd., New Carlisle, Que., Canada.

CALGARY & KNEEHILL.—Extension of time asked until March 15, to build first 30 miles of line from Calgary, Alb., northerly to Kneehill creek, and a further extension of two years from that date for the completion of the rest of the line. The directors include F. Aylwin, Ottawa, Ont.; P. Roy and J. E. Laurencelle, both of Edmonton.

CANADIAN LIVERPOOL & WESTERN.—Incorporation to be asked soon to build from the Grand Trunk Pacific, near the St. Maurice river, Que., northeasterly to the south shore of Lake St. John, thence east along the Saguenay river, with a branch from the mouth of that river southwesterly along the St. Lawrence to Quebec and Montreal. Smith & Johnston, solicitors, Ottawa, Ont.

CANADIAN NORTHERN.—The Rossburn branch extension, previously referred to as the Brandon-Regina line, recently put in operation from Rossburn, Man., west to Regina, Sask., 220.8 miles, is eventually to be extended west to a point near the western boundary of Saskatchewan.

——Building branch from Dalmeny, Sask., north about 45 miles. Track laid last year from Dalmeny to Laird, 28 miles.

——Building from Etolmami, Sask., northeast via Pas Mission, Keewatin, to Fort Churchill, on Hudson bay, 588 miles. Track laid on 120 miles from Etolmami northeast. The Dominion government has agreed to subsidize and guarantee bonds for the 488 miles from Pas Mission to Hudson bay.

——The Goose Lake branch, building from Saskatoon, Sask., southwest, has track laid to Zealandia, Sask., 75 miles from Saskatoon. Graded for 20 miles further.

——Extension of the Edmonton & Slave Lake in operation from Edmondton, Alb., north to Morinville, 23 miles, projected north via Athabasca Landing and the Lesser Slave lake to Peace river, about 400 miles.

——Extension of the line built from Strathcona, Alb., into Edmonton, 4½ miles, and 21 miles from Edmonton west to Stony Plain. Projected west to the boundary of British Columbia, passing south to Jasper House, about 200 miles west of Edmonton. Extension also projected north of this line from Edmonton northwest to the British Columbia boundary, 300 miles.

CANADIAN NORTHERN ONTARIO.—Work under way from Ottawa, Ont., east to junction with Canadian Northern Quebec at Hawkesbury, 55 miles. It is expected that the line will be ready for traffic in March.

——Subsidy granted for a line from Sutton Junction, Ont., to Hatton Mines, not to exceed 30 miles.

——The main line between Toronto, Ont., and Sudbury, 268 miles, is now completed, as are the branches to the Moose mountain mines at Sellwood and to Key Harbor the company's Georgian bay port. Surveys being made west for 550 miles, to be built from Moose mountain mines to a connection with the Canadian Northern lines at Port Arthur.

——Application is to be made for authority to build lines as follows: From Nepigon bay, Ont., to the National Transcontinental Railway, with branch lines to the northern and southern ends of Lake Nepigon; from Vermillion bay to the National Transcontinental crossing of the Abitibi river, thence to the south end of Lake Temiskaming.

——Application to be made for an extension of time to build authorized lines in Ontario as follows: from Washago to Kincardine; Arnprior to Gananoque; Pembroke to Cobourg; Pickering to Owen Sound; Niagara to Goderich; Port Dover to Owen Sound; Hawkesbury to Toronto; Parry Sound to North Bay; French River to Batchewana, and Toronto to Ottawa.

CANADIAN NORTHERN QUEBEC.—Contract let to J. P. Mullarkey, of Montreal, for extension from St. Jacques, Que., to Rawdon, 11 miles. Grading under way.

——Subsidy contracts, at $3,200 a mile, made with the Canadian government for a line from near Arundel, Que., to a point near the united townships of Preston, Que., and Hartwell, about 30 miles.

CANADIAN PACIFIC.—Building extension of the Northern Colonization Railway from Nomininque, Que., west to Rapide de L'Original, in Wright district, 35 miles. Track laid to mile 32.7.

——The Georgian Bay & Seaboard building from Victoria Harbour, Ont., to Cold Water, 13.3 miles. Track laid on 10 miles.

——Building extension of the Winnipeg Beach line, from Komarno, Man., north to Icelandic river, 30 miles.

——Work under way on 18 miles to complete the double-tracking from Winnipeg, Man., east to Fort William, 427 miles. Foley, Welch & Stewart, contractors, Winnipeg.

——Building branch from Regina, Sask., north to Bulyea, 43 miles.

——Building extension of the Yorkton branch from Sheho, Sask., northwest to Lanigan, 82 miles. Track laid from Sheho to Wynward, 46.10 miles, in operation to Leslie, 24 miles.

——Extension of Stoughton-Weyburn line projected from Weyburn, Sask., west 100 miles to Range, 30, west of the second meridian.

——Projected branch from Moose Jaw, Sask., northwest to Lacombe, Alb., 375 miles. Grading from mile 50 to mile 123. Contract let to J. D. MacArthur, Winnipeg, for work from Moose Jaw north via Tuxford to point 30 miles beyond Rutland, 50 miles. Finished for 119.1 miles. Work also under way from Lacombe, east on 100 miles towards Moose Jaw. Surveyed and 51 miles in operation east to Stettler, Alb. Foley, Welch & Stewart, contractors.

——Line from Saskatoon, Sask., west to Wetaskiwin, Alb., 325 miles. Contract let to Foley, Welch & Stewart, from Wetaskiwin, east to Battleford, 250 miles. Built from Wetaskiwin east to Hardisty, 95 miles and from Saskatoon west to Wilkie, 99.6 miles.

——Reconnoissance for proposed line from Killam, Alb., northwest to Strathcona, 80 miles.

McLeod, for new line from Lethbridge, Alb.,
——Contract let to Janse & McDonald, of west to McCloud, 36 miles. Grading finished. Belly river bridge, 5,327 ft. long, 60 per cent finished. Work just started on Old Man river bridge, 1,890 ft.
——Contract reported let to McDonnell & Gzowski, of Vancouver, B. C., and work under way improving the main line grades near Field, B. C. The improvements include two new tunnels aggregating about a mile and a half, one on each side of the Kicking Horse river, and two bridges. To cost about $1,500,000. Work 85 per cent. finished.
——Proposed route inspected for branch line from Penticton, B. C., to Coutlee. Work is to be started at once.
——Contracts let to John Bright, of Vancouver, and Dixon & Moore, of Parkesville, B. C., to extend the Esquimalt & Nanaimo from Wellington, B. C., to French Creek, 23 miles. Surveys made for further extension of 35 miles from French Creek to Alberni, at the east end of the Alberni canal, island of Vancouver.

CANADA WEST COAL COMPANIES RAILROAD.—Work to be begun early this year on a line from Calgary, Alb., south to the smelters at Butte, Mont. Address O. A. Robertson, St. Paul, Minn.

CENTRAL ONTARIO.—Grading finished on an extension north of Maynooth, Ont., for 11½ miles, and track laid on 10½ miles. Work on the rest of the 27½ miles to Whitney, suspended for the present.

CROWS NEST & NORTHERN.—Surveys filed for a line from Crows Nest, B. C., to Crown, over 12 miles. J. A. Williams, Pres., and C. O. Diffenderfer, Ch. Eng., Spokane, Wash.

EASTERN BRITISH COLUMBIA.—Building from the south fork of Michel creek, B. C., on the Crows Nest branch of the Canadian Pacific, south 14 miles. D. Corbin, Pres.; E. G. Taber, Ch. Engr., Fernie, B. C.

EDMONDTON & SLAVE LAKE.—See Canadian Northern.

ESQUIMALT & NANAIMO.—See Canadian Pacific.

GEORGIAN BAY & SEABOARD.—See Canadian Pacific.

GRAND TRUNK PACIFIC.—To extend from Moncton, N. B., west 3,550 miles across Canada to Prince Rupert, B. C., a new port on Kai En Island, about 25 miles south of Port Simpson. The total length of all the projected lines is 7,900 miles.
——Moncton to Winnipeg, Man., 1,804 miles, called the National Transcontinental, to be built by the Canadian government. Contracts let for all this eastern section except 1.11 miles covered by the Quebec bridge and approaches. Track laid at end of 1908 was 309.15 miles, of which 39.71 are in New Brunswick, 120.99 in Quebec, and 148.45 in Ontario and Manitoba. Contracts let as follows:
——To Grand Trunk Pacific Railway Co., of Montreal, Que., in District A from near Moncton, N. B., west 50 miles.
——To John W. McManus Co., Ltd., of Memramcook, N. B., in District A, from near Chipman, N. B., easterly 8 miles.
——To Grand Trunk Pacific Railway Co., in District A, from 58 miles west of Moncton to about mile 97.7 at the Intercolonial Railway, 39.7 miles.
——To Grand Trunk Pacific Railway Co., in District A, from mile 97.7 west to Tobique river at about mile 165.7 less one mile, about 67 miles.
——To Willard Kitchen Co., Ltd., of Grand Falls, N. B., in District A, from near Tobique river west to 2.5 miles west of Grand Falls, N. B., about 31.5 miles.
——To Lyrons & White, of Edmundston, N. B. in District A, from near Grand Falls, westerly to the Quebec-New Brunswick boundary, about 62 miles.
——To M. P. & J. T. Davis, of Quebec, in District B, from the Quebec-New Brunswick boundary westerly about 52.4 miles.
——To M. P. & J. T. Davis, in District B, from near the Quebec bridge easterly about 150 miles.
——To Macdonell & O'Brien, of Montreal, in District B, from the north end of the Quebec Bridge & Railway Co.'s bridge to near La Tuque, Que., about 150 miles.
——To Grand Trunk Pacific Railway Co., in District B, from 150 miles west of the Quebec bridge, westerly to Weymontachene, about 45 miles.
——To Macdonell & O'Brien, in District C, from near Weymontachene, Que., westerly about 107 miles.
——To Macdonell & O'Brien, in District C, from 107 miles west of Weymontachene, westerly to the end of the G. T. P. Railway Co.'s contract, about 114.97 miles.
——To Grand Trunk Pacific Railway Co., in Districts C and D, from 8 miles west of the Abitibi river crossing Ontario, easterly about 150 miles.
——To E. F. & G. E. Fauquier, of Ottawa, Ont., in District D, from 8 miles west of Abitibi river crossing, westerly about 100 miles
——To M. P. & J. T. Davis, in Districts D and E, from the westerly end of Fauquier Bros' Abitibi contract westerly about 104.24 miles.
——To M. P. & J. T. Davis, in District E, from 60 miles west of the eastern boundary of District E in Ontario, westerly to end of Fauquier Bros' contract north of Lake Nepigon, about 100 miles.
——To E. F. & G. E. Fauquier, in District E, from about 19.5 miles west of the Mud river crossing near Lake Nepigon, Ont., easterly about 75 miles.
——To O'Brien & McDougall, of Ottawa, Ont., in Districts E and F, from the western end of Fauquier Bros' contract, north of Lake Nepigon, westerly to near Dog lake, about 126 miles.
——To O'Brien & McDougall in District F, from near Dog Lake, Ont., to 2.6 miles west of Peninsula Crossing, about 24.13 miles.
——To J. D. McArthur, of Winnipeg, Man., in District F, from near Winnipeg east to Peninsula Crossing, near the junction point of the Fort William branch of the G. T. P. Ry., about 245 miles.
——The western line, Winnipeg, Man., via Saskatoon, Sask., Edmonton, Alb., and Yellow Head pass to Prince Rupert, 1,750 miles, and the Lake Superior branch east of Winnipeg to Fort William, to be built by Grand Trunk Pacific.
——The main line is under construction from Winnipeg, Man., west to mile 916, at the eastern foot of the Rocky mountains; also on the western end from mile 1655, west to mile 1755, 100 miles. Track laid at various points up to end of 1908 as follows: Province of Manitoba, Winnipeg, west 212.32 miles, Saskatchewan, mile 212.32, to mile 627.10—414.78 miles; Alberta, mile 627.1, to mile 685—57.9 miles, and from mile 786.6 to mile 791.6, five miles, a total of 690 miles. Surveys under way from mile 1045, west to mile 1655. The line is not under construction from mile 916 to mile 1655—739 miles.
——Work under way on a branch from the main line at Kitimat, B. C. (Pacific Northern & Omineca), to mile 53.7. Foley, Welch & Stewart of Stony Plains, Alb., and Prince Rupert, B. C., are the contractors. Contracts for about 300 miles are to be let soon.
——Extension of time of two years has been granted to the Grand Trunk, Pacific Branch Lines Co. for the following branches from the main line of the Grand Trunk Pacific: Belt line around the city of Winnipeg, Man., and through the outlying portions of that city. Winnipeg, Man., to a point on the international boundary within 25 miles east or west of the Red river.
——Neepawa, Man., to a junction with the Grand Trunk Pacific to Brandon and from thence to Regina, Sask.
——Line from Brandon to a point on the southern boundary of the province near Turtle mountains.
——From a point on the western division near township 22, range 6, west of the second meridian, to Yorkton, Sask., thence to a port on Hudson's bay.
——From the same point as the above branch southward to Regina, Sask., and thence to the international boundary near North Portal.
——From a point on the western division between 105th and 107th degrees of longitude to Prince Albert, Sask.
——From a point on the western division between 108th and 109th degrees of longitude to Prince Albert, Sask.
——From a point on the western division between 111th and 113th degrees of longitude to Calgary, Alb., and from thence to the international boundary near Coutts, Alb.
——From Vancouver, B. C., to a junction with the Grand Trunk Pacific or to a junction with the Pacific Northern & Omineca, or both between the 122d and 124th degrees of longitude.
——From a point on the north shore of the island of Vancouver southerly to Victoria, B. C.
——From a point on the western division between 127th and 129th degrees of longitude to Dawson City, Y. T.

GREAT NORTHERN.—See Great Northern under United States.

HALIFAX & GUYSBOROUGH.—Location surveys made by the Canadian government for a line from Halifax, N. S., northeast to Guysborough via Lawrencetown, Musquodoboit Harbor, Little River. Upper Musquodoboit and Cole Harbor, 165 miles, also for a number of branch lines. G. E. Boak, of Halifax, is interested.

INTERCOLONIAL.—Double-tracking between Moncton, N. B., and Painsec Junction, 7 miles Three-quarters finished. Surveys made.
——Surveys made for relocation of line from Georges river, Nova Scotia, to Sydney mines for double track from Painsec Junction to Sackville, 30.75 miles, and from Amherst via Parrsboro to Truro, 90 miles. Work not yet decided upon.

INTERNATIONAL LUMBER CO.'S ROAD.—This 5-mile logging road now in operation from Campbell River, B. C., is to be extended 25 or 30 miles into the island of Vancouver. C. H. Cobb, Pres.; F. H. Parks, Mgr., Campbell River, B. C.

INTERNATIONAL RAILWAY OF NEW BRUNSWICK.—A new subsidy contract has been made with the Canadian government for building an extension from the western end of the 20 miles already built from Campbellton, N. B., to a point on the St. John river, between Grand Falls and Edmundston.

MANITOULIN LINE & NORTH SHORE.—See Algoma Central & Hudson Bay.

MATANE & GASPE.—Building from Metis, Que., from a junction with the Intercolonial near St. Octave de Metis via Matane to Gaspe; also westward from the junction with the Intercolonial to Rimouski; and on the eastern end from Gaspe to Griffin cove, a total of 286½ miles. A branch is projected from near Metis southwest to the Grand Trunk Pacific near Glazier lake. Right of way is nearly all secured. Contract let to the H. J. Beemer Co., Quebec, for building from point near St. Octave de Metis east to Matane, 31 miles. The second section to be built will be from Matane east to Ste. Anne des Monts, 60 miles. Contract is to be let shortly for the remaining section from Ste. Anne des Monts east to Gaspe, 127 miles. Senator P. A. Choquette, President, Quebec, and P. E. Hunter, Ch. Engr., Ste. Flavie, Quebec.

NORTHERN COLONIZATION.—See Canadian Pacific.

PRINCE ALBERT & HUDSON BAY.—Organized to build from Prince Albert, Sask., northeasterly to the mouth of Nelson river or York Factory, on Hudson bay. F. W. Halliday, solicitor, Prince Albert, Sask.

PRINCE EDWARD ISLAND RAILWAY.—Bids in for the construction of a branch line from Harmony, P. E. I., to Elmira Kings county, 10 miles, by D. Pottinger, General Manager, Moncton, N. B.

QUEBEC CENTRAL.—Surveys being made for an extension from St. George, Que., to St. Justine, 30 miles, to be built this year.

QUEBEC & LAKE ST. JOHN.—Surveys made for an extension to be built this year from Roberval, Que., northwest to St. Felicien, 20 miles.

ST. MARY'S & WESTERN ONTARIO.—Organized to build from Woodstock, Ont., northwest to St. Mary's, thence to Exeter and then south and west to Sarnia, 125 miles. Surveys made. Built from Embro to St. Mary's, 18 miles, and is operated under lease by the Canadian Pacific. Subsidy granted for the entire line.

TEMISKAMING & NORTHERN ONTARIO.—Extension of Englehart-Charlton branch located from Charlton, Ont., to Elk lake, 19 miles.

VANCOUVER, VICTORIA & EASTERN.—See Great Northern, under United States.

MEXICO.

CANANEA, YAQUI RIVER & PACIFIC.—See Southern Pacific.

INTEROCEANIC OF MEXICO.—Heavy grades and sharp curves to be removed gradually, and new stretches of road so built that a change from narrow to standard gage may be made later.

LA DICHA & PACIFIC.—Concession granted by the federal government to this company amended to provide that 12½ miles were to be finished by February 25, 1909, and an additional 12½ miles finished every year thereafter up to 1914. The general offices are at La Dicha, Guerrero.

MEXICAN CENTRAL.—Surveys reported made for rebuilding division between Irapuato, Guanajuato and Guadalajara, 161 miles. The estimated cost is $2,000,000.
——Work reported suspended on the Tampico cut-off, building from Mexico City

east to Tampico, 304 miles. About 191 miles remains to be built.
——Large terminal to be built at Manzanillo. About 1,000 acres of land bought.

MEXICAN ROADS.—Surveys being made for a 200-mile line from the San Carlos mines via Sierra Rica to a point on the Kansas City, Mexico & Orient, or to the Southern Pacific in Texas, about 200 miles. Estimated cost $21,000 a mile. The promoters are: Albert Terrazas, Governor Creel, Manuel Gameros and Dr. C. F. Z. Caracristi, San Carlos de Ojinaga, Chihuahua, Mex.
——Gustavo A. Madero, of Zacetecas, has a concession to build from Comacho, Zac., east to Mazapil, 60 miles.
——The Mexican Milling & Transportation Co. has a concession to build lines in Guanajuato, La Pas and Santa Rosa, with branches, in all 50 miles. G. W. Bryant is interested.

MEXICAN SOUTHERN.—Building an extension from Oaxaca, Mex., in the state of Oaxaca, south via Zimatlan and San Pablo Huixtepec to Taviche, 34 miles. Built from Oaxaca to San Pablo, and grading contract let for the remaining 16 miles to Taviche.

PACIFIC, GULF & YUCATAN.—See Pan-American.

PAN-AMERICAN.—This company has concessions for a line to Panama through San Salvador and Nicaragua.
——The Pacific, Gulf & Yucatan is a projected branch from Jalisco, Chiapas, to point in State of Yucatan, 660 miles.

RIO GRANDE, SIERRA MADRE & PACIFIC. Work on the extension west from Terrazos toward the Pacific coast is to be resumed when financial conditions improve. The first section to be built will be about 175 or 200 miles. Graded for about 30 miles. The projected route is from Nueva Casas Grandes, Chihuahua, southwest, via Santa Elena and Ocampo, to a point on the Pacific coast, either at Guaymas or at Topolobampo, 300 miles.

SAN JUAN, TAVICHE & OAXACA.—An extension of two years from May 9, 1908, granted to C. A. Hamilton, of Oaxaca, to build from San Pablo Zimatlin, Oaxaca, to the Taviche mining camp, about 17 miles.

SONORA RAILWAY.—See Southern Pacific.

SOUTHERN PACIFIC (Mexico).—The Southern Pacific Railroad of Mexico, formerly referred to as the Mexican Pacific Coast, building from Navajoa, Sonora, south of Corral on the Cananea, Yaqui River & Pacific, southeast to Guadalajara, Jalisco, 730 miles. From Navojoa south the line is in operation to Culiacan, 218 miles. Graded south of Culiacan to Quila, and track laid on 6½ miles. The roadbed north of Mazatlan is finished on 32 miles and track laid on 25 miles south of Mazatlan graded for 12½ miles and track laid on 9½ miles. It is expected that the line will be in operation in 3 years. Work progressing. The Grant Bros. Construction Co., contractors, Los Angeles, Cal.
——Concession granted authorizing the construction of as many branches on either side of the trunk line from Navojoa to Guadalajara (each branch not to exceed 93.15 miles long) as may be desired to be designated prior to November, 1915. No concession for the construction of parallel lines within a zone of 20 miles on each side of the line can be granted to any other company prior to November, 1920.
——The Cananea, Yaqui River & Pacific is building a branch from Corral, Sonora, north along the Yaqui river. Projected to international boundary, near Douglas, Ariz., 388 miles. The concession calls for the completion of the line by May, 1914. Built to Aguas Calientes, 60 miles. Grant Bros. Construction Co., Los Angeles, Cal., has contract to Tonichi.
——The Cananea, Yaqui River & Pacific has a concession from the Mexican government for a branch from Naco, east to Juarez, Sonora, 150 miles.
——Branch to be built from Tonichi to coal fields of Barranca, 4½ miles.
——Work under way by the Grant Bros. Construction Co., of Los Angeles, Cal., on branch from the Yaqui river line Sonora, at the junction of the Yaqui and Moctezuma rivers, north to Nacozari, 111 miles. The concession calls for the completion of the line by May, 1914.
——The Sonora Railway is to be rebuilt from Nogales, Ariz., to Guaymas, Mex., 265 miles. Concession for this improvement work granted.

SOUTHERN PACIFIC RAILROAD OF MEXICO.—See Southern Pacific, under Mexico.

TORRES, PRIETAS & REPRESO.—Operating 19 miles of railway from Torres, Sonora, on the Sonora Railway east to Prietas. Projected 80-mile extension east to the Yaqui river.

TUXPAN-FURBERO.—Percy M. Furber, of the Oil Field Co., of Mexico City, is building a line from Furbero, Vera Cruz, to the port of Tuxpan, 50 miles. Track laid from Tuxpan to Cazones, 20 miles. A. C. Payne, Gen. Mgr., Mexico City.

VERA CRUZ TERMINAL.—Contracts let to S. Pearson & Sons, Sucs., London, and the Campania Bancaria de Obrasy Bienes Raices of Mexico City for new terminal buildings and improvements at the Port of Vera Cruz, Mex., to cost about $8,000,000. J. W. Richardson, Ch. Engr., City of Mexico.

PENNSYLVANIA STATION AT NEW YORK.

The plans for the Pennsylvania's New York passenger station were shown in the *Railroad Gazette* of February 9, 1906, and May 25, 1906. The station building and yards cover the six blocks bounded by Ninth avenue, Thirty-third street, Seventh avenue and Thirty-first street. Within the 25 acres of ground area are 16 miles of tracks. The two single-track tubes under the Hudson river run east as far as Tenth avenue. Here the tracks will spread out and be multiplied so that at Ninth avenue there will be 21. This number continues to a point under the eastern part of the station building, which covers all the space from Eighth avenue to Seventh avenue, when the tracks begin to converge and finally pass into two double-track tunnels running eastward across to the East river.

The accompanying photograph of the front of the station on Seventh avenue (Fig. 1) was taken from the corner of Thirty-first street and Seventh avenue, looking northwest. The stone work of this facade is completed, and most of this work is finished on the Thirty-first street side, at the left in the photograph. Fig. 2 shows the progress of the work on the Eighth avenue face of the building. The highest steel work is over the main waiting room, while the low steel arches are over the concourse. Fig. 3 is a nearer view of the Eighth avenue face, taken from the Thirty-third street, or north, side of the excavation. Fig. 4, looking north, shows the eastern side of the Ninth avenue work. The street is supported on girders and concrete work; forms for the latter are in the foreground at the left. The temporary timber supports for the Ninth avenue elevated railway are visible in Fig. 5, which shows the west side of Ninth avenue. Fig. 6 is a near view of the same side, but near Thirty-first street. Grading is all finished east of Ninth avenue, but west of and under Ninth avenue there is still some rock excavation to be done, as shown

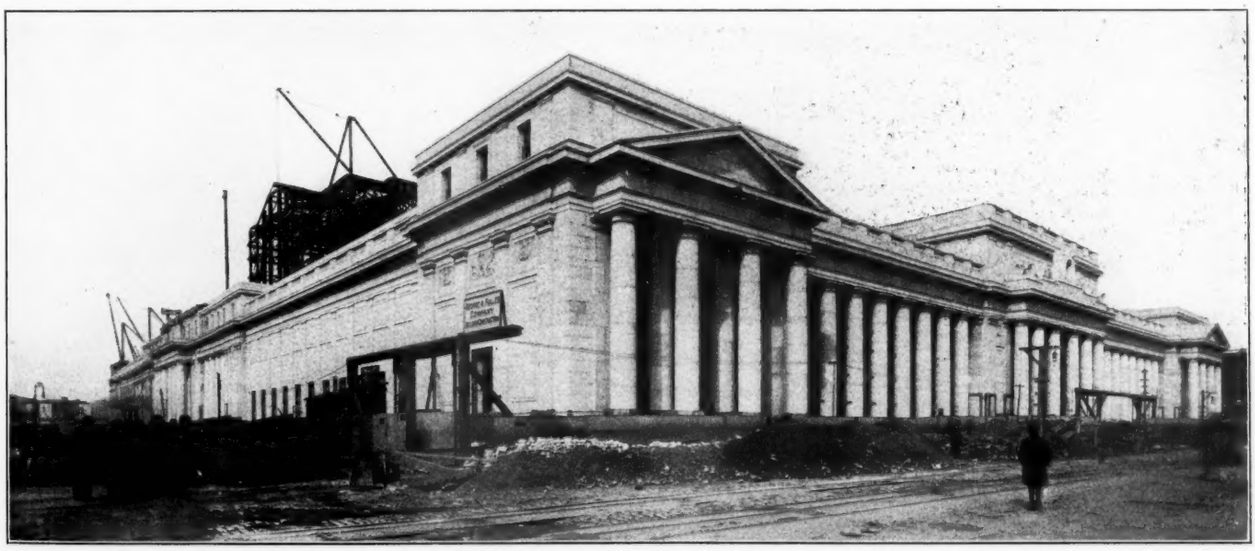


Fig. 1—Main Facade; Pennsylvania Station.

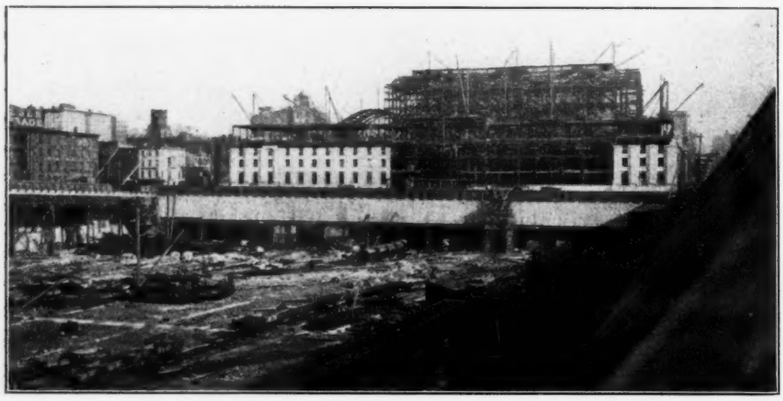


Fig. 2.

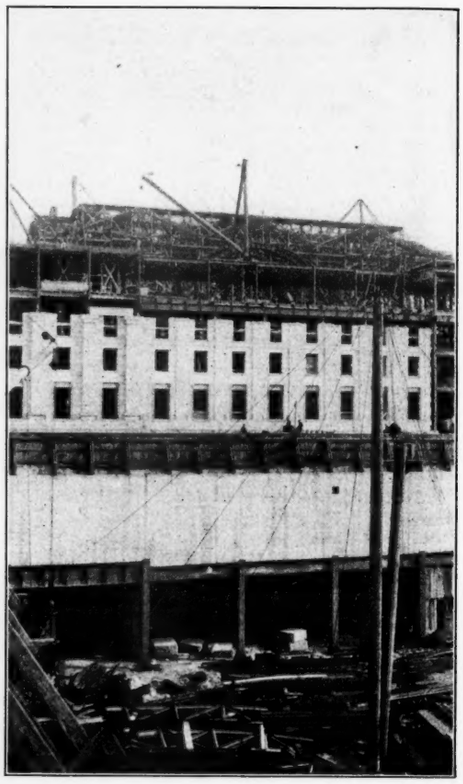


Fig. 3.

Fig. 4.

Fig. 5.

Fig. 7.

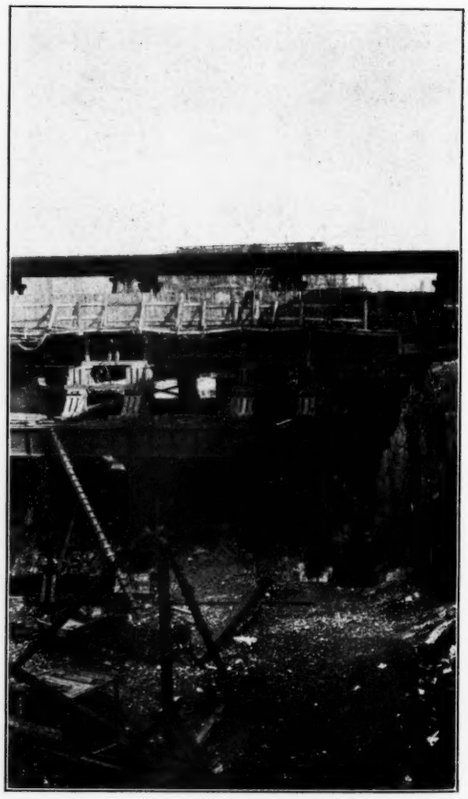


Fig. 6.

in Figs. 5 and 6. The last view, Fig. 7, was taken from Ninth avenue, looking west toward the tube portals. The upper halves of these portals, which are timbered, may be made out at the left of the foot of the trestle in the distance, behind the derrick in the middle of the excavation.

RAIL JOINTS.

Many joints have been designed which theoretically seemed to satisfy every requirement, but have failed in actual service, because the treatment which a joint under traffic has to stand cannot be figured out in the foot-pounds. It may give excellent service at first on new rail in well ballasted and well surfaced track; on poorer track, or as soon as the joint becomes slightly worn, it fails.

To get some definite information as to the efficiency of different kinds of joints, we invited engineering officers of some important roads in the country to send blueprints of the joints they had in approved use, their experience with them, and their opinions of the value of them and of other joints they have tried. No attempt was made to gather complete statistics, and therefore any percentages as to the comparative number of each kind of joint in use, worked out from the answers received, are only indicative and not conclusive. It must be remembered also that since the roads concerned are large ones, with many miles of track laid with plain angle bars, changes of standards mean great expense. This is not so true of smaller roads. The proportion of patented joints in approved use, figured from our returns, is therefore lower than the proportion now being bought if every road in the country were considered.

Fifty-six answers were received. Taking up first those roads which had in approved use plain angle bars rather than patented joints, Fig. 1 shows the section of angle bar to which the practice of the majority of roads conform. The variations from this section, as applied to 80 and 85-lb. rail, are in many directions. A comparatively frequent one is the thickening of the vertical web to ⅞ in. Another tendency is to put more metal into the upper part of the web near the underside of the rail head. An extreme development of this latter practice is shown in the Pennsylvania's angle bar for use with its new section of rail. Fig. 2 shows this section as applied to 100-lb. rail; the one for 85-lb. rail shows the same tendency, though not so marked. The horizontal extension of the lower flange of the bar is another direction in which the angle bar section is frequently modified. Fig. 3 shows an extreme design. The greatest variations occur in rails lighter than 80 lbs. A pronounced characteristic is the simplification of the general lines, making the rolling simpler. In these lighter joints this is natural, because the amount of metal used being comparatively small, it is not found to be economical to carry far the refinements resulting in a more advantageous disposition of metal. On 70-lb. rail the widely extending lower flange occurs frequently.

The four-hole 24 to 26-in. joint is at present the most common length. For six-hole joints, 30 in. is the most popular. In both cases the joints are suspended. Both joints are applied to rails from 80 to 100 lbs. Extreme lengths are in a few cases still in approved use. In four cases, six-hole joints 40 in., and more, long are used. One road using a 40-in. bar with 90-lb. rail under heavy freight traffic finds it makes a very satisfactory joint, and no trouble with battered rails developed, The same road uses a four-hole 24-in. joint on side tracks. A second road uses a 44-in. joint with a wide flange on 72-lb. rail. It considers it a good joint, especially with rail of good quality, but it is quite likely to bend, particularly if the head of the rail becomes battered. The other two use 40 and 42-in. joints with 75-lb. rail. One considers it the best joint on the market, but the other intends to use hereafter a thicker four-hole 24-in. bar instead. One of the largest roads uses a six-hole 38-in. bar with 100-lb. rail. They have been breaking lately, and the engineer believed that they do not give better service in proportion to their additional cost and the extra amount of material in them as compared with a 25-in. bar. In a three-tie supported joint he found that unless the middle tie is constantly tamped up, the joint becomes a long suspended joint. Eleven roads report six-hole joints from 28 to 37 in. long. These are all large roads, with fast heavy freight service. They are used on rails 80 to 100 lbs. These are nearly all suspended joints, and several engineers call attention to the need of careful tamping. One road, which is changing to one of the patented joints for its 1909 requirement on double track, is, however, still using a 36-in. supported joint on single track, considering it much better than a two-tie joint for traffic in both directions. With this joint, 95-lb. rail is used, and the bars have wide flanges, giving a broad bearing on the tie at each side of the rail base similar to the one shown in Fig. 3. The other roads using angle bars as standards use four-hole bars from 22 to 26 in. long. They are nearly all suspended joints.

Nut locks, or lock nuts, are used on about two-thirds of the six-hole joints reported. The proportion is still greater on four-hole joints. The bolts are placed alternately on the outside and inside of the rail. This makes the joint symmetrical and may perhaps balance strains. The main reason for this, however, is that in case of derailment the wheels will cut off nuts on one side of the rail only, leaving enough fastening to hold the joint together temporarily. There are records of cases where wheels have been off the track, shearing bolts, for miles before discovery. There are a number of different arrangements, both bolts at the ends of the rails sometimes having the nuts on the same side, while the next two have the nuts on the other side. There are several cases, however, where all the bolts have the nuts on the same side. The advantage of this is that a man can see all the nuts more easily in inspecting.

Among the unusual angle bar joints is the design used by the Atlanta, Birmingham & Atlantic, shown in Fig. 4. This, as shown, has the vertical web reinforced somewhat like the Sampson joint and is used with 80-lb. A.S.C.E. section rail. The Chicago & North Western and the Chicago, St. Paul, Minneapolis & Omaha use a base plate ⅜ in. thick under the rail running the length of the angle bar. The plate extends out $1^5/_{16}$ in. on each side of the rail base, being thickened in this portion to ⅝ in. The spikes connect it with the angle bar above. The Central of Georgia uses a joint plate in connection with its standard four-hole 26-in. angle bar joint, with 80-lb. A.S.C.E. rail. The officers of the above consider these joints the equal of base-supported joints. They may be criticized in that they cannot act as a unit, their only connection between the angle bar portion and the base plate being due to pressure of the spikes, which for this purpose is negligible.

Two roads report the use of fish plates. On the first, they are in use on old, very light rails only. The other, the Mexican Railway, uses them not because it likes them, but because it is the only thing that can be used on the greater part of its lines, due to the design of steel tie in service.

The Norfolk & Western in 1892, and for two or three years after that, bought a good many rails of 60 ft. lengths with mitered joints. Some of this rail is still in track on the Shenandoah division, where traffic is somewhat light. On other divisions where traffic is heavy, this rail has been worn out and removed from main track, the best of it being relaid on some side lines. The company stopped buying 60-ft. rails solely because of the premium asked by the mills because of the difficulty in strengthening it. This premium amounted to more than the saving resulting from fewer joints. The extra width of opening necessary to allow for expansion is also undesirable and the mitered joint has not been successful, the acute angle being subject to wear and having

other disadvantages similar to the troubles developing with switch points.

Nearly all the roads report the use, to a greater or less extent, of one or more forms of patented joints. The majority of them favor patented joints and were either planning to come to their use ultimately for main line traffic, at least when they decided just what design they preferred, or else said that the increased first cost and difficulty of applying were the only objections. In one instance the ordinary angle bar joint was considered little, if any, inferior to any patented joint now on the market, taking into consideration the additional cost of applying them. This criticism cannot be fairly made against patented joints in general. This officer called attention to the fact that no joint will keep the rail up without work under the ties supporting the joint, and he had not found that the need for this was reduced to any great extent by any patented joint. Other roads, while feeling that certain patented forms are far preferable to the ordinary angle bars, have not yet worked up enough figures as to the saving in maintenance to be able to decide what they can afford to pay for improved joints. Improvements are being made steadily and a better joint than any in service is to be hoped for.

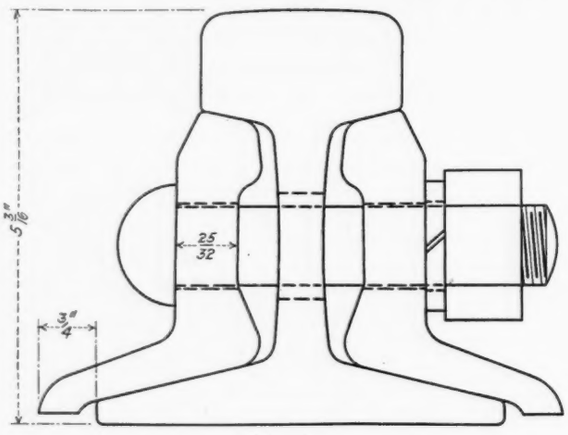


Fig. 1.

In considering the different kinds of patented joints it must be remembered that the figures here given are by no means complete. As mentioned at the beginning of this article, reports from only a comparatively small list of roads were received, and the proportions of these roads which favor certain kinds of joints only suggest comparative value. There are six patented joints which are now in service in sufficient numbers to merit consideration. They may be divided into two classes: those with deep girder flanges, namely the Hundred per cent., the Duquesne and the Bonzano; the base-supported type, consisting of the Continuous, the Weber and the Wolhaupter.

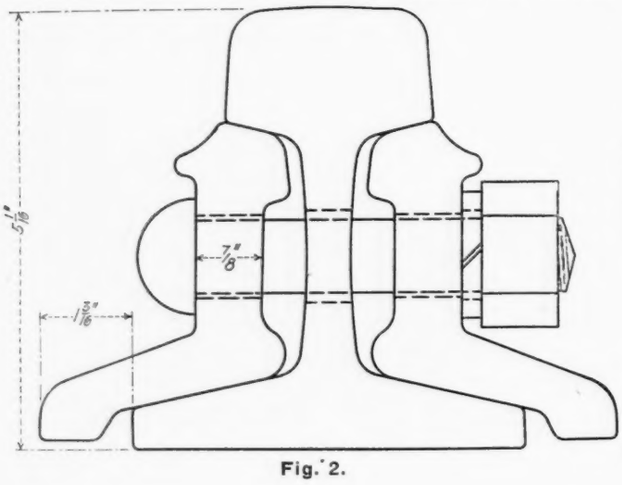


Fig. 2.

A recent form of the Hundred per cent. joint is shown in Fig. 5. Of the 56 roads reporting, 11 spoke of trials of the Hundred per cent. joint and four had it in approved use either as a standard or buying it in large quantities. One road which uses these joints and the Duquesne, Fig. 6, under heavy traffic and angle bars under light traffic found that the angle bar cost from two-and-a-half to three times as much per mile of track per month to maintain as the two kinds of patented joints. Another road has had 80 miles of Hundred per cent. joint under 100-lb. rail in service for five years and reports them in excellent condition. It also has had about 30 miles of these joints on 80-lb. rail for over six years and they are giving as good service. Four roads report trials of Duquesne joints, and it is being bought for 1909 requirements by two roads which are also buying Hundred per cent. joints.

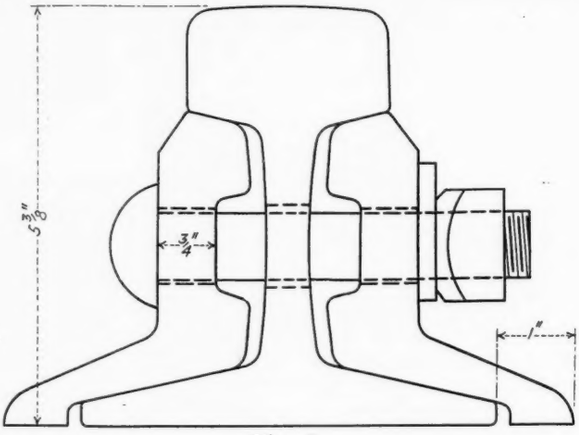


Fig. 3.

Fig. 7 shows a recent type of the Bonzano joint. In other forms of this joint the depending flange is deeper and correspondingly thinner. Eleven roads reported trials of the Bonzano joint and five of them have quantities in approved service.

The Continuous joint, Fig. 8, is reported as having been tried by 23 of 56 roads in question and 16 roads have it in approved use. One road, which is perhaps the largest user of Continuous joints, says that the improved alinement and service of this joint is so great that in running from the old angle bar track laid with Continuous joints, one's

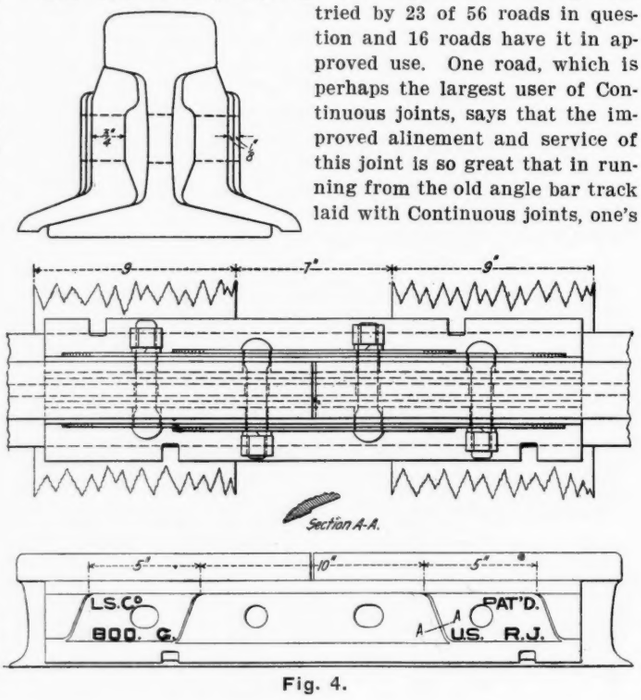


Fig. 4.

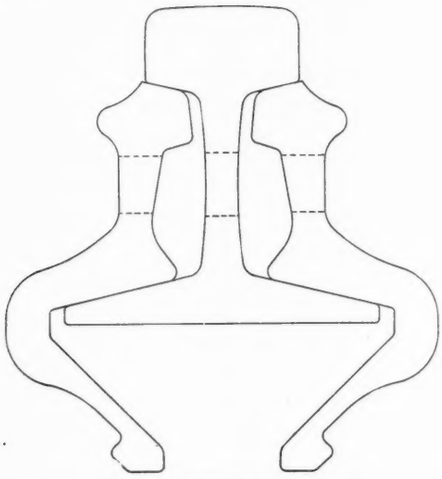


Fig. 5—Hundred Per Cent.

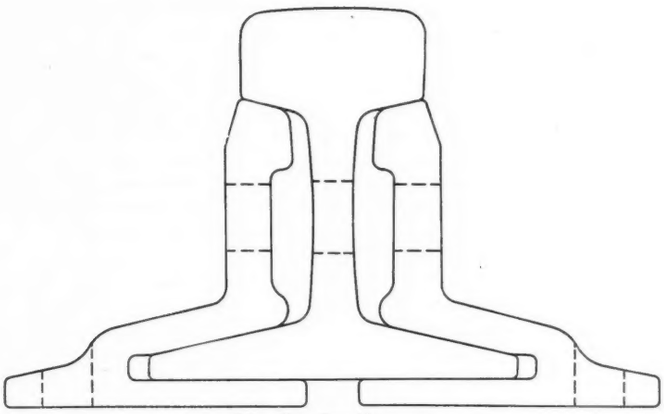


Fig. 8—Continuous.

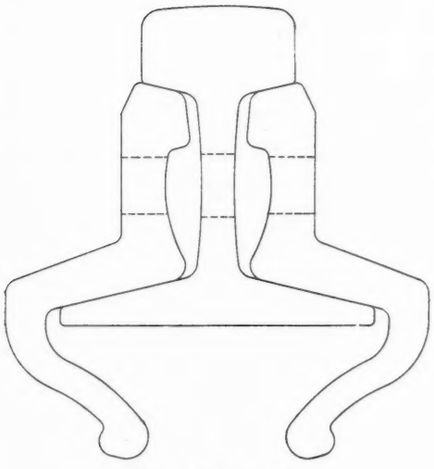


Fig. 6—Duquesne.

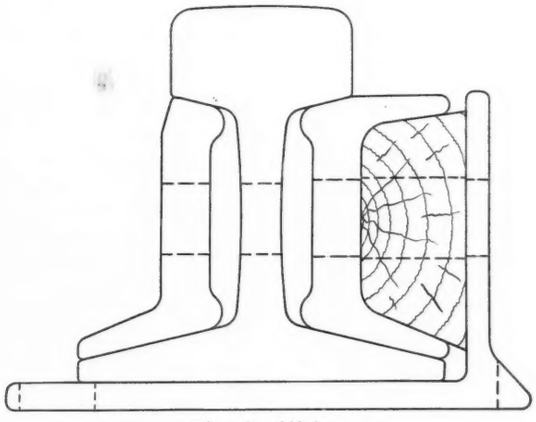


Fig. 9—Weber.

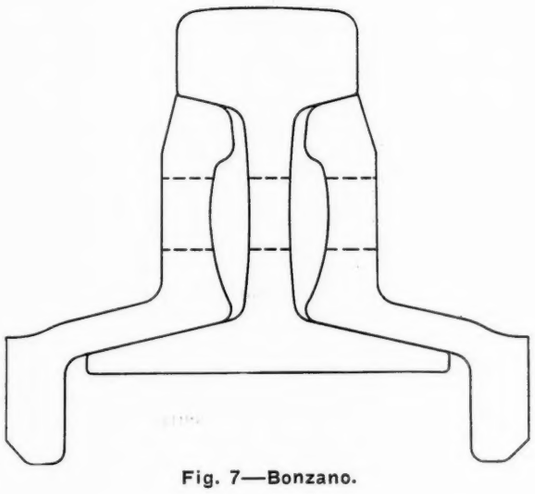


Fig. 7—Bonzano.

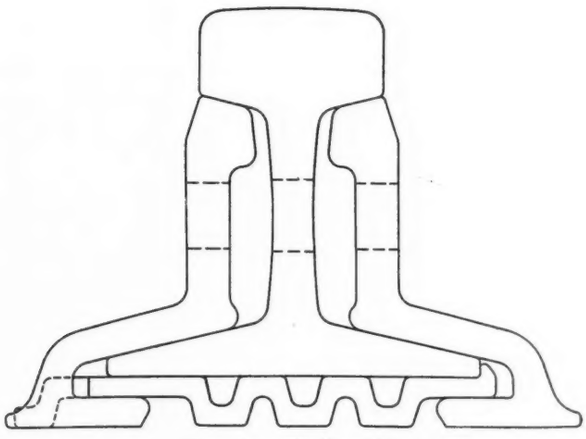


Fig. 10—Wolhaupter.

attention is at once attracted by the smoother riding. An officer of an electric road which has been replacing angle bars with Continuous joints considers it the best adapted to elevated track, because of its being a two-piece joint. There is less noise and he believes that it supports the rail better than any other type. In applying the joints his people are as careful as possible to see that the ends of the rail are well cleaned off and free from scale, and the base of the rail was usually daubed with oil or grease so that the joint would fit up snug and get a uniform bearing. Nut locks were used, and two or three days after the nuts had been set they were again tightened up and the nut lock then turned down into position. In many cases he found that where the ends of the rails were uneven, the joints were causing them to wear smooth. Another road reports that its trackmen say they need to pay very little more attention to the joints than to the rest of the track, except for tightening up the bolts occasionally. An officer of another road believes that on dirt and thinly ballasted track these joints can be kept tighter at less cost than the ordinary angle bars.

The Weber joint, Fig. 9, has been tried by 17 of the roads, and it is reported in approved use by three. One road has used it entirely for many years in connection with renewing 75 and 85-lb. rail. This road gives as the particular advantages of this joint the fact that, when first assembled, it adapts itself well to irregularities in the rail, and that the slight give of the side plate and wood filler block makes an effective nut lock. As a defect, a tendency to kick slightly after bolts had been secured is mentioned. An officer of another road which has been using Weber joints as standard for the last 10 years says that the wood filler made previous to five years ago were not quite thick enough, and he has been therefore replacing some of those used nine or ten years ago. He says that if he were ordering new rails for branch lines where traffic was light, he would order common angle bars, but that such branches are now being relaid with rails taken from the main lines, and Weber joints are being transferred with the rails. He says the cost of maintenance of these joints has been very small. Another road which has been using only about 20 miles of Weber joints on 60-lb. rail, being the only patented joint in use on that line, reports they have not been used long enough to say exactly what the cost of maintenance is as compared with ordinary angle bars, after allowing for the increased cost of the Weber joints. Probably, however, the cost of maintaining ordinary joints is a fourth or more greater. An officer of the road which spoke of the use of Continuous joints on dirt and thinly ballasted track considers that the decreased cost of keeping joints tight was still more noticeable with the Weber joint. The Wolhaupter joint, Fig. 10, has been tried by five roads. Its advantages seem to be possessed to a full extent by the Continuous and other Weber joints.

FOREIGN RAILWAY NOTES.

The shares of the Western Railway of France, which was acquired by the state during 1908, sold for 829 francs at the beginning of the year, and at 944 at the end of it, so that the purchase was profitable to the shareholders at least.

The German Dining-Car Co., during its fiscal year ending with September, 1908, extended its service over three additional routes, added 12 to the number of its cars, bringing it up to 75, of which 25 are 12-wheeled cars. Its net earnings during the year were sufficient for a 10 per cent. dividend.

Even German newspapers sometimes exaggerate. One of them recently told a story of a pocketbook containing 17,000 marks ($4,060) found in the cushion of a car sent to the shop for repairs, and regarded it as probable that it was stolen money which the thief hid in the cushion and did not dare to claim. Further investigation shows that in fact a pocketbook was found in the cushion of a car when repaired in the shop, and that this pocketbook did contain money; not 17,000 marks, however, but 2 pfennige (less than half a cent) and a pawn ticket for 6 marks.

The Swiss state railways earned 1 per cent. less in 1908 than in 1907, and their working expenses were nearly 4 per cent. greater—largely due to higher wages. This results in a decrease of 10 per cent. in net earnings. To economize, the number of passenger trains will be reduced next summer.

COLOR BLINDNESS.

"The Imaginary Dangers of Color Blindness" was the title of a brief note quoted from Prof. J. W. Baird, published in the *Railroad Age Gazette* of January 8, page 81, and the title at once caught the sharp eye of Dr. Charles H. Williams, of Boston, the inventor of the Williams lantern for testing railway men's eyes; and he wants to know why we use such a title. The dangers of color blindness are not imaginary, of course; and they have often been pointed out in these columns; and Dr. Williams's point is well taken. What we had in mind in writing that title was the fact that theorists continue to indulge excessively in wordy refinements of this subject long after all practical questions relating to it have been settled. The theorists seem to imagine that dire disaster is going to result if they do not prove to the whole world the soundness of their theories to the last detail; whereas the actual dangers of color blindness have been practically done away with. The railways all know enough now to exclude color blind persons. These dangers were almost neutralized before Professor Holmgren and the other pioneers pointed out the facts and the remedy, for color-blinds had a remarkable facility in distinguishing the right light from the wrong one, by various comparisons, in spite of their infirmity. But, whatever the gravity of the danger, the remedy is so simple that the railway or steamship company which does not exclude color blinds from its engines and pilot houses would now be hard to find. Dr. Williams cites a case of a pilot who mistook a red light for a green one near Norfolk, Va., in 1875, and caused a collision resulting in the loss of ten lives; and another (no date given) of a color blind engineman who was himself killed in a collision caused by his running past a red signal. The proof in these cases would be challenged, no doubt, in a lawsuit, and not without influence on a jury; but this is not an important point, from the railway manager's standpoint, for, the safeguard being so easily provided, it is to his interest to apply it, even if the dangers be very remote.

Dr. Williams advises that his lantern, to use in connection with colored worsteds, for testing eyes, is now standard on ten prominent railways. The list of these roads, with the years in which they adopted the combined system, is as follows:

New York, New Haven & Hartford	1899
Great Northern	1901
Boston & Maine	1902
Northern Pacific	1903
Australian lines	1904
Erie	1905
Canadian Pacific	1906
New York Central & Hudson River	1906
Chicago, St. Paul, Minneapolis & Omaha	1907
Southern Railway	1908

As our readers well know, the Williams lantern, which has been heretofore described and which is shown on another page of this issue, is a valuable supplement to the worsted test, in that it is so arranged as to make an image minute enough to detect color blindness in the small central area of the retina, which sometimes occurs, from the use of tobacco, in men not congenitally color blind. This defect is not detected by testing with yarns at short range, because the image is so large as to extend beyond the affected area.

General News Section.

Beginning January 1, 1909, the Interstate Commerce Commission will require monthly reports of earnings from the express companies.

It is reported in Canada that the Canadian Pacific will, this summer, run a train through between Montreal and Vancouver, 2,896 miles, in 72 hours. This is 24 hours quicker than the best time ever made in the past, and averages about 40 miles an hour, including stops.

At Washington last week Messrs. Knapp and Neill, who constitute the government mediation board, listened to statements from the two general managers of the Pennsylvania and the leader of the firemen's brotherhood concerning differences between those roads and their firemen. The firemen presented to the commissioners a long list of grievances, nearly all of which the managers had refused to adjust.

The Brooklyn Rapid Transit Company, operating the street railways of Brooklyn, has been called upon to comply with the federal hours-of-labor law, interstate freight traffic being conducted over one of the company's minor lines. It appears that some of the telegraph or telephone operators employed by the company have tried to invoke the law for the purpose of reducing their hours. The officers of the company say that none of the operators is engaged in any work which affects the safety of trains.

The Interstate Commerce Commission has ordered the railways to report by May 1 the number of freight cars owned, number equipped with air-brakes and average percentage of air-braked cars used in trains during the six months ending Feb. 28, 1909, together with a statement of the instructions issued by the carrier respecting the use of air on its line; and on May 5 the commission will give a hearing on the question of increasing the present minimum percentage of power-braked cars which shall be operated in each train.

The Railroad Commission of Texas has given out a statement that the freight earnings of Texas lines increased $2,361,459, or 7.44 per cent., during the six months ended December 31, 1908, as compared with the same months in 1907; that passenger-train earnings decreased during the same period $286,151, or 2 per cent.; that other earnings increased $22,447, or 15 per cent.; that gross earnings increased $2,097,756, or 4 per cent.; that operating expenses decreased 7.9 per cent., and that income from operation increased 51 per cent.

Steps are being taken toward the organization in Chicago of a club to be called the Chicago Railway Club. It is believed that the Rock Island Railway Club can be made the nucleus for a larger organization. This club has been in existence for two years and is composed mainly of the chief clerks in the various departments of the Rock Island in Chicago and of men holding positions substantially similar in rank. C. Nyquist, Chief Clerk of the Secretary and Treasurer of the Rock Island, is Chairman of the committee that is seeking to bring about the organization of the larger club. Railway men from vice-presidents down to assistant chief clerks would be eligible to membership in the proposed club.

Personal damage suits against the railways in Texas rose from $223,749 in 1891 to $1,018,636 in 1900. The Southern Pacific lines in Texas in the past nine years have settled 8,776 claims for personal injuries, of which 90 per cent. were settled without suit. Other roads settled from 75 to 95 per cent. of such claims without suits. These are among the figures that were recently submitted to the legislature in opposition to a bill to render invalid contracts of settlement for personal injuries made by railways within 90 days after the date of the injury. It was shown that out of all the settlements of suits made out of court only 23 were subsequently attacked; and of these 14 were set aside.

Railway Supplies, Imports and Exports.

The monthly summary of commerce and finance of the United States for December, 1908, gives the figures for that month and for the complete year 1908, comparing them with the figures for December, 1907, and the years 1906 and 1907. The figures for December, 1908, and the totals for 1908 are subject to revision.

The imports of machinery into the United States in December, 1908, were valued at $260,392 as compared with $328,998 in 1907, and the value of machinery imported in the year 1908 was $3,242,765 as compared with $4,566,897 in 1907.

The following table gives the value of exports of freight and passenger cars and parts:

	For steam railways.	For other railways.
December, 1908	$527,066	$165,375
December, 1907	581,486	467,941
Year 1908	5,727,330	1,677,143
Year 1907	9,191,023	2,141,346

One of the most noticeable decreases in the export of cars is the decrease in value of cars exported to British North America. In 1908 this value was $487,135, and in 1907 it was $1,493,175. The loss for the month of December is even greater proportionately. In December 1908, the value was $14,678, and in December, 1907, the value was $43,922.

In 1908, 196,510 tons of rails were exported, valued at $6,021,549, while in 1907, 338,906 tons were exported, valued at $10,411,072, and in this case also, the falling off in the month of December was more than proportional to the falling off in the whole year. There were exported 10,243 tons of rails, valued at $305,143, in December of last year as compared with 20,763 tons, valued at $640,682, in December of 1907.

The following table shows the countries to which rails were exported and the respective amounts and values in 1907 and 1908:

Exported to—	1908. Tons.	1908. Value.	1907. Tons.	1907. Value.
Europe	2,246	$66,452	496	$17,108
British North America	14,807	421,883	37,216	1,110,758
Cent. America and Br. Honduras	8,172	234,892	28,715	860,313
Mexico	61,687	1,965,435	32,930	1,052,189
West Indies and Bermuda	19,702	560,913	28,165	863,598
South America	28,510	817,212	85,919	2,437,100
Japan	22,070	679,874	34,922	1,102,931
Other Asia and Oceania	38,437	1,249,984	88,470	2,936,330
British Africa	365	11,040	277	7,741
All other Africa	514	13,864	796	23,004

There were 116,878 tons of structural steel, valued at $6,289,610, exported in the year 1908 as compared with 138,442 tons, valued at $7,784,618, in 1907. In the month of December, 1908, 9,935 tons, valued at $508,832, were exported as compared with 9,401 tons, valued at $495,557, in 1907. It will be seen that the December figures show a gain, while the figures for the year show a loss.

In 1908 there were 48,380 car wheels, valued at $387,662, exported. In 1907 there were 43,082 car wheels, valued at $348,142, exported. In December, 1908, 3,358 car wheels, valued at $28,128, were exported, as against 5,885 car wheels, valued at $49,755, in 1907.

The value of electrical machinery exported during the 1908 year was $6,956,722 as against $9,735,230 in the previous year, and the value of electrical machinery exported in December, 1908, was $587,559 as compared with $837,811 in December of the previous year. The exports to the United Kingdom, to British North America and to Mexico show the most noticeable decreases, British North America especially, the value of exports of electrical machinery to that country being $579,409 in the year 1908 as compared with $1,543,450 in 1907. The exports to Japan of this machinery, on the other hand, fell off only slightly. They were valued at $1,232,958 as compared with $1,411,229 in 1907.

The value of metal working machinery exported showed even a greater proportion of shrinkage, the figures for 1908 being $5,205,606 and for 1907, $10,142,835. The figures for the month of December show relatively about the same shrinkage. The value exported in December, 1908, was $363,140 and in 1907, $741,835. Here again the exports to the United Kingdom and to Germany as well show a large shrinkage in value, but the exports to British North America only show a comparatively small shrinkage in value.

There were exported in the year 1908, 566 locomotives, val-

ued at $6,319,309, and in 1907, 885 locomotives, valued at $9,080,337. In the month of December, 1908, there were 29 locomotives, valued at $294,981, exported as compared with 58 locomotives, valued at $619,355. The following table shows the number and value of locomotives exported to different countries for 1907 and 1908:

	1908.		1907.	
Exported to:	No. of locos.	Value.	No. of locos.	Value.
Europe	33	$685,986	27	$602,657
British North America	99	542,406	216	1,516,034
Central America and Br. Honduras	13	74,850	79	846,062
Mexico	79	978,672	50	467,705
Cuba	26	198,916	76	710,666
Other West Indies and Bermuda	8	56,365	2	12,688
Argentina	54	843,385	16	206,491
Brazil	46	519,949	47	745,776
Other South America	51	492,587	78	1,125,850
Chinese Empire	10	119,300	2	12,235
Japan	39	354,025	71	588,318
British Australia	2	13,000	78	109,603
Philippine Islands	5	27,285	10	60,148
Other Asia and Oceania	100	1,402,408	132	2,072,979
Africa	1	10,175	1	3,125

American Society of Civil Engineers.

At the meeting of the American Society of Civil Engineers to be held on Wednesday, March 17, 1909, at 8.30 p.m., a paper entitled "Steel Sheeting and Sheet-Piling" will be presented by L. R. Gifford, Assoc. M. Am. Soc. C. E. This paper was printed in the February proceedings.

Illinois Fuel Conference.

The United States Geological Survey, acting in co-operation with the Illinois State Geological Survey and the University of Illinois, has established a mine explosion and mine rescue station at Urbana, Ill. The purpose of the station is to interest mine operators and inspectors in the economic value of such modern appliances as oxygen helmets and resuscitation apparatus as adjuncts to the normal equipment of mines. The station also will concern itself with the training of mine bosses and others in the use of such apparatus. Its service is to be rendered gratuitously so far as possible to all in Illinois, Indiana, Michigan, western Kentucky, Iowa and Missouri who may desire the benefits thereof.

The formal opening on March 11 of the laboratory at Urbana was attended by a conference extending over three days. At the first session, addresses were made by President Edmund J. James of the University of Illinois, J. A. Holmes, representing the United States Geological Survey, A. J. Moorsehead, representing the Illinois Coal Operators, and T. L. Lewis, representing the United Mine Workers. At the afternoon session of that day demonstrations were made in the use of the helmets and in resuscitation work by R. Y. Williams, Mining Engineer, United States Geological Survey. In the evening there was an address on "Mine Explosions: What the United States Geological Survey is Doing to Prevent Them," by J. A. Holmes, Chief of the Technical Branch of that department, and one on "The Work of Foreign Mine Explosion Stations," by G. S. Rice, Mining Engineer, of the same department.

Friday morning the meeting was addressed by C. W. Balke, Associate Professor in Chemistry, University of Illinois, on "The Chemistry of Explosives," and the conference discussed "Mine Explosions and Their Causes," the principal speakers being David Ross, James Epperson and Joseph Taylor. The afternoon conference was devoted to the subject of "Smoke Suppression," and the discussion was participated in by Paul P. Bird, W. A. Evans, A. Bement and L. P. Breckenridge. At the evening session addresses were made on "First Aid Work in the Anthracite Mines," by H. H. Stoek; "The College of Engineering and the Mining Interests of Illinois," by W. F. M. Goss, and "Work of the University of Illinois Engineering Experiment Station," by L. P. Breckenridge. The conference dealt with "Economy in the Use of Fuel for Industrial and Domestic Use," the speakers being A. Bement, D. T. Randall, R. H. Kuss, Edward H. Taylor and J. M. Snodgrass.

At the closing session on Saturday an address was given on The Fuel Resources of the Country, by George Otis Smith, Director, United States Geological Survey; one on The Fuel Interests of the State, by H. S. Bain, Director State Geological Survey; and one on Coal Analysis, by N. W. Lord.

It is expected that these addresses and the principal parts of the discussion will be published in a bulletin issued by the Engineering Experiment Station of the University.

Resolutions were adopted looking to another annual conference, and asking the legislature of Illinois for an appropriation for the establishment of a School of Mining Engineering in connection with the University of Illinois.

The Pullman Company.

The total revenue of the Pullman Co. for the fiscal year ended June 31, 1908, amounted to $31,620,241 as compared with $32,186,013 in 1907. The total expenses of operation were $18,001,759 in 1908, and $17,388,741 in 1907. There was $3,362,238 charged for depreciation of cars and other property of the company in 1908 as against $2,421,597 in 1907. Dividends of $7,998,356 were declared last year, and $7,476,878 in the previous year. There was a net surplus of $1,790,568 for 1908, and $4,149,455 in 1907.

No balance sheet is given as of July 31, 1907, but the balance sheet as of July 31, 1908, shows cash on hand of $9,054,320, and sundry accounts receivable of $3,074,343. There is carried as a liability reserve for depreciation and adjustment accounts $5,509,025, and there are sundry accounts payable of $1,617,875.

MEETINGS AND CONVENTIONS.

The following list gives names of secretaries, dates of next or regular meetings, and places of meeting.

Air Brake Association.—F. M. Nellis, 53 State St., Boston, Mass.; May 11-14, 1909; Richmond, Va.

American Association of Demurrage Officers.—A. G. Thomason, Scranton, Pa.; May 11; St. Louis, Mo.

American Institute of Electrical Engineers.—R. W. Pope, 33 West 39th street, New York; second Friday in month; New York.

American Railway Association.—W. F. Allen, 24 Park Place, New York; May 19, 1909; New York.

American Railway Bridge and Building Association.—S. F. Patterson, B. & M., Concord, N. H.; Oct. 19, 1909; Jacksonville, Fla.

American Railway Engineering and Maint. of Way Assoc.—E. H. Fritch, Monadnock Bldg., Chicago; March 16-18, 1909; Chicago.

American Railway Master Mechanics' Association.—J. W. Taylor, Old Colony Bldg., Chicago; June 16-18, 1909; Atlantic City.

American Society of Civil Engineers.—C. W. Hunt, 220 W. 57th St.; N. Y.; 1st and 3d Wed., except July and August; New York.

American Society of Mechanical Engineers.—Calvin W. Rice, 29 W. 39th St., N.Y.; 2d Tues. in month; annual, Dec. 7-10; New York.

American Street and Interurban Railway Association.—B. V. Swenson, 29 W. 39th St., New York.

Association of American Railway Accounting Officers.—C. G. Phillips, 143 Dearborn St., Chicago; April 28, 1909; Cincinnati.

Association of Railway Claim Agents.—E. H. Hemus, A., T. & S. F., Topeka, Kan.; last week in May, 1909; Detroit, Mich.

Association of Railway Telegraph Superintendents.—P. W. Drew, Wisconsin Central Ry., Chicago; June 23-25, 1909; Detroit.

Association of Transportation and Car Accounting Officers.—G. P. Conard, 24 Park Pl., New York; June 22-23; Montreal.

Canadian Railway Club.—James Powell, Grand Trunk Ry., Montreal, Que.; 1st Tues. in month, except June, July and Aug.; Montreal.

Canadian Society of Civil Engineers.—Clement H. McLeod, Montreal, Que.; irregular, usually weekly; Montreal.

Central Railway Club.—H. D. Vought, 95 Liberty St., New York; 2d Friday in January, March, May, Sept. and Nov.; Buffalo.

Freight Claim Association.—Warren P. Taylor, Rich., Fred. & Pot. R.R., Richmond, Va.; June 16, 1909; Old Point Comfort, Va.

International Master Boiler Makers' Association.—Harry D. Vought, 95 Liberty St., N. Y.; April 27-30, 1909; Louisville, Ky.

International Railway Fuel Association.—D. B. Sebastian, La Salle St. Station, Chicago; June 21-23, 1909; Chicago.

International Railway General Foremen's Association.—E. C. Cook, Royal Insurance Bldg., Chicago; June 1-5; Chicago.

Iowa Railway Club.—W. B. Harrison, Union Station, Des Moines, Ia.; 2d Friday in month, except July and August; Des Moines.

Master Car Builders' Association.—J. W. Taylor, Old Colony Bldg., Chicago; June 21-23, 1909; Atlantic City.

New England Railroad Club.—G. H. Frazier, 10 Oliver St., Boston, Mass.; 2d Tues. in mnth, ex. June, July, Aug. and Sept.; Boston.

New York Railroad Club.—H. D. Vought, 95 Liberty St., New York; 3d Friday in month, except June, July and August; New York.

North-West Railway Club.—T. W. Flannagan, Soo Line, Minn.; 1st Tues. after 2d Mon., ex. June, July, Aug.; St. Paul and Minn.

Railway Club of Pittsburgh.—J. D. Conway, Pittsburgh, Pa.; 4th Friday in month, except June, July and August; Pittsburgh.

Railway Signal Association.—C. C. Rosenberg, 12 North Linden St., Bethlehem, Pa.

Railway Storekeepers' Association.—J. P. Murphy, Box C. Collinwood, Ohio; May 17-19; Chicago.

Roadmasters' and Maintenance of Way Association.—Walter E. Emery, P. & P. U. Ry., Peoria, Ill.; Nov., 1909; Washington.

St. Louis Railway Club.—B. W. Frauenthal, Union Station, St. Louis, Mo.; 2d Friday in month, except June, July and Aug.; St. Louis.

Southern Association of Car Service Officers.—J. H. O'Donnell, Bogalusa, La.; April 15; Altanta, Ga.

Southern and Southwestern Ry. Club.—A. J. Merrill, Prudential Bldg., Atlanta; 3d Thurs., Jan., April, Aug. and Nov.; Atlanta.

Traveling Engineers' Association.—W. O. Thompson, N. Y. C. & H. R. R.R., East Buffalo, N. Y.; September, 1909; Denver.

Western Railway Club.—J. W. Taylor, Old Colony Bldg., Chicago; 3d Tuesday each month except June, July and August; Chicago.

Western Society of Engineers.—J. H. Warder, Monadnock Bldg., Chicago; 1st Wednesday, except July and August; Chicago.

New York Railroad Club.

The next regular meeting of the New York Railroad Club will be held on Friday evening, March 19. No special technical paper will be presented and discussed, but a number of experts of recognized authority in the electrical and railway world have been invited to address the club on whatever question relating to electrification of railways appeals to them as being at this time of vital interest and importance. Several have elected to speak on "The Approaching Transfer of the Electrification Problem," "How Much Standardization is Desired from Present Knowledge of Electrification," and "How Much or How Little Can Be Done as Small Portions of Lines Are Electrified to Approach a Final Standardization?". Definite acceptances to speak have been received from L. B. Stillwell, W. S. Murray, Electrical Engineer of the N. Y., N. H. & H. R. R.; N. W. Storer, of the Westinghouse Electric & Manufacturing Co.; Henry G. Stott, C. L. de Muralt, William McClellan and Frank J. Sprague, all of New York.

Tentative affirmative responses have been received from Bion J. Arnold, of Chicago; J. E. Muhlfeld, of Baltimore; L. C. Fritch, Consulting Engineer of the Illinois Central, Chicago; George Gibbs, of New York. An opportunity will be afforded for such as desire to speak on the question and give their views on the "Abuse of the M. C. B. Repair Card." Members having changes to recommend in the Interchange Rules are requested to send them to the secretary, who will forward them to the secretary of the M. C. B. Association for the Arbitration Committee's consideration.

Traffic News.

The Central New York Car Demurrage Bureau had a total number of cars reported for February of 57,312, with an average detention by the railways of 0.33 days, and by the consignees of 1.34 days.

The Lake Superior Demurrage Bureau reports that in February, 1909, 22,848 cars were reported and an average detention of 1.18 days as compared with 21,479 cars reported in February, 1908, and an average detention of 1.18 days.

The Nashville, Chattanooga & St. Louis has given notice that the uniform bill of lading will be put into effect on its lines April 1, 1909. Shippers will be permitted to use up forms, which they now have on hand under the usual regulation.

The monthly report of the Pacific Car Service Bureau for January, 1909, shows that 86,380 cars were reported, of which 75,250 were commercial and 11,130 company cars. The commercial cars held overtime totalled 6,410, as compared with 6,285 in January, 1908, and the company cars 1,706, as compared with 2,390 in January, 1908.

The Pennsylvania Railroad has arranged with the Pennsylvania State College of Agriculture to run an educational train on March 23, 24 and 25. In furtherance of its plans, the railway lately took its agents between Harrisburg and Williamsport and between Lemont and Montandon to State College that they might become informed as to the crops that can be raised with profit on the farms in their individual neighborhoods. This next instruction train will cover the territory tributary to the Northern Central between New Freedom and Sunbury. Special efforts will be directed towards interesting the farmers in alfalfa, corn improvement, forestry, soil tillage and fertility, and dairy husbandry.

A meeting of the traffic executives of the railways in Missouri was held in St. Louis on March 11 to consider what action should be taken in regard to passenger fares in that state, in view of the decision of the Federal court holding the state 2-cent fare law unconstitutional. Ne decision was reached and the matter will be considered again at a later conference. It is well known that some of the roads wish to restore the 3-cent fare while others favor adopting on the main lines, at least, a 2½-cent fare as suggested by Judge McPherson. It is not improbable that Governor Hadley and Attorney-General Major will be conferred with to see if a compromise cannot be made under which the roads will put in a 2½-cent fare and the state will not appeal the case to the Supreme Court. However, Attorney-General Major has definitely announced that he will appeal.

N. A. Stedman, attorney for the principal railways in Texas, has given out a statement analyzing the Texas Railroad Commission's report of the earnings of the railways in that state during the six months ended June 30, 1908. The commission's figures showed that there had been substantial increases in both gross and net earnings. Mr. Stedman says that the earnings of the roads for the last six months of 1908 were better than for the last six months of the previous year, not because business was what it ought to have been in the later period, but because it was exceedingly unsatisfactory in the earlier period. While the income from operation was greater in the last six months of 1908 than in the same months of 1907, it was less than in the same months of 1906. On 14 lines doing nine-tenths of the business in the state, earnings during the last half of 1908 were $2,600,000 less than in the same months of 1906. Based on the value placed on the roads by Mr. Thompson, former Engineer of the Texas Commission, in recent testimony before the Interstate Commerce Commission, Mr. Stedman estimated that the roads, after paying operating expenses and taxes, earned 4.7 per cent. in the year ended June 30, 1906; 6 per cent. in the year ended June 30, 1907, the best year in their history, and only 2.85 per cent. in the year ended June 30, 1908.

INTERSTATE COMMERCE COMMISSION.

Unlawful Combination.

Mayor and Aldermen of the City of Bristol, Tenn., v. Virginia & Southwestern et al. Opinion (831) by Commissioner Harlan. Case 1297.

While evidence of unlawful combinations are always admissible as part of the history of the rate of which complaint is made, and may often throw light on the question of its reasonableness, the unlawful combination, standing by itself, without proof also of the unreasonableness of the rate, is not a sufficient ground for an order reducing the rate.

Complainant's contention that the rate here involved is discriminatory as compared with the rates of one of the defendants from Middlesboro to Knoxville is not sustained, as the circumstances surrounding the shipments from Middlesboro are dissimilar.

Under all the circumstances shown of record the flat rate of 85 cents per ton for the transportation of both steam and domestic coal from the Appalachia coal field in Virginia to Bristol, Tenn., is unreasonable. The rate of 75 cents per ton will yield a fair and reasonable compensation.

Adjusting Rates to Get Long Haul.

Chamber of Commerce of Milwaukee v. Chicago, Rock Island & Pacific et al.—Opinion (832) by Commissioner Harlan. Case 1615.

The complainant, and those on whose behalf the petition herein was filed, are entitled to through routes to Milwaukee from the points in question on the lines of that part of the system of the Chicago, Rock Island & Pacific that was formerly the Burlington, Cedar Rapids & Northern, and to reasonable joint through rates for the movement over those routes of corn, rye and oats to the Milwaukee market. The joint through rates on those grains from such points ought not for the future to exceed the through rates on those grains to Chicago.

In claiming that as Chicago affords as good a market for grain as does Milwaukee, the principal defendant may therefore lawfully so adjust its rate schedules as to force the grain to Chicago, the defendant overlooks the right of the shipper to choose his own market and to do business where he prefers or finds it more advantageous to carry it on. It also overlooks the chief function of a common carrier, which is to carry at reasonable rates the traffic that is tendered to it.

A carrier has no right to insist that a shipment shall go to the end of its rails if the shipper desires it to be diverted

at an intermediate point to another market off its rails. Nor may a carrier accomplish these results indirectly by any unreasonable adjustment of its rate schedules with that end in view. It cannot lawfully compel the shipping public to contribute to its revenues on any such grounds.

L. C. L. Shipments of Inflammable Products.

National Petroleum Association and National Refining Co. v. Louisville & Nashville.—Opinion (835) by Chairman Knapp.

Under the circumstances of the case, the rule enforced by defendant, restricting the receipt and shipment of L.C.L. lots of coal oil and products of petroleum to one day in each week, found to subject complainants and other like dealers to undue and unreasonable prejudice. Any rule which restricts shipments of the oils in question to less than two days in any week is unreasonable, and the days selected for the receipt of these commodities should be separated by at least two intervening days.

STATE COMMISSIONS.

The Railroad Commission of Louisiana has canceled its order of March 10, 1904, adopting a uniform bill of lading for use in Louisiana, and has ordered that the standard forms of "straight" and "order" bills of lading approved by the Interstate Commerce Commission on June 27, 1908, be used for shipments between points in Louisiana. The order is effective March 15.

The Railroad Commission of Louisiana has authorized the application of Southern Classification No. 36 on intrastate shipments. The commission found that there had been both reductions and advances in rates by changes in the classification, but that the necessities of shipping demand changes from time to time and the remedy of any shipper who considers any of the rates excessive or unreasonable is to complain to the commission.

COURT NEWS.

In the Supreme Court at White Plains, N. Y., March 11, a suit brought by the New York Central against John Smith, a milk dealer, for reparation in a case where milk had been carried for Smith at less than the published rates, the decision was in favor of the road. In his decision Judge Tompkins says: "The contract between the plaintiff and defendant for a freight rate less than the tariff rate fixed by the schedule, filed and posted under the Public Service act, was and is illegal, and does not protect the defendant, or bind the plaintiff, and the plaintiff is entitled to recover the difference between the rate fixed by the filed and posted schedule and the amount paid under the said illegal agreement."

In the United States Circuit Court of Appeals, at Baltimore, March 13, Judges Goff, Pritchard and Morris, the petition of the Baltimore & Ohio for an injunction against the Interstate Commerce Commission in the matter of reporting excessive hours worked by employees was denied, and the road ordered to pay the costs of the proceedings. The Interstate Commerce Commission, as a part of its regulations for enforcing the laws limiting the working hours of trainmen and telegraphers, called upon all the railways to report regularly all cases in which men had worked longer periods of time than those specified in the law; and the Baltimore & Ohio and other roads refused to make such reports, claiming that the information given would tend to incriminate the company, and that therefore, under the constitutional provision, the information need not be given. It is said that suits brought by various other railways for injunctions will be held in abeyance until the B. & O. case is decided.

Judge Farrington, of the United States Circuit Court at Carson City, Nev., has rendered a decision sustaining the constitutionality of the law of that state creating a state railroad commission. On the subject of maximum rates established by the commission, the court holds that in the case of the Central Pacific the rates are not confiscatory. The Nevada & California rates are held insufficient, but the company was denied an injunction because the commission had taken no action to enforce the maximum rate. In the case of the San Pedro, Los Angeles & Salt Lake the evidence does not show the rate to be confiscatory. The court holds that the Eureka & Palisade, the Tonopah & Goldfield and the Virginia & Truckee failed to substantiate their cases against the state. The bills are all dismissed and the restraining orders vacated, but the dismissal of the bill of the Nevada & California is without prejudice.

The Nevada legislature last week passed a new railway commission bill. It gives the commission power to regulate fares and freights "reasonably" and does away with the maximum rate law.

The constitutionality of the New York State Public Service Commissions law was upheld by a unanimous decision last week by the Appellate Division of the Supreme Court. Justice Clarke wrote the decision. The court says: "The act is a valid exercise of legislative power. It is the latest expression of the public policy of the state in reference to public service corporations. The right of the state to regulate and control corporations has always been asserted and recognized. The subject matter is clearly indicated in the title. There is no constitutional objection to embracing several separate matters in a general as distinguished from a private or local bill. * * * The fact that a part of the moneys necessary to meet expenditures is raised, in the wisdom of the legislature, by taxation upon a portion of the state makes those officers none the less state or general officers, and does not bring the expenditure within the prohibition of the constitution. The act is general, not private or local; it contains no matter not germane to the title thereof; the provision for payment of the expenses of the commissions created is properly included in the act creating them; the provision requiring payment of a portion thereof by taxation on a specified district is but a matter of apportionment, well within the taxing power of the legislature, and no indebtedness within the meaning of Section 10, Article 8, of the constitution is to be incurred. The act is a valid exercise of legislative power."

The Steinway tunnel—the tunnel under the East river, New York, from Forty-second street, Manhattan, to Queens, cannot be seized by the city as a penalty for non-compliance by the company with the provisions of the charter. This is the substance of a decision of the Appellate division of the Supreme Court, which holds that although the original company—the New York & Long Island Railroad—has ceased to exist, its property is now rightfully held by the trustees for the benefit of the stockholders, and the court holds that the franchises and rights granted by the aldermen are property, and do not lapse with the forfeiture of the charter. It is expected that the trustees, who were the directors of the company, will now procure the organization of a new company.

The decision, written by Justice Clarke, says: "The corporation has ceased to exist, and its powers incidental to corporate existence, derived from the state, have been forfeited to the state. These powers it can no longer exercise. But as the state has said its powers shall cease, so it has said also that its property shall be preserved and vested in its directors as trustees for the benefit of its creditors and members. This corporation has nearly completed its road; it is physically in the streets as to which it had a consent. It has expended large sums of money which it was only enabled to get by virtue of the consent of the local authorities, which consent had become attached to the tangible property put into construction and by the purchase of private property through a portion of which the road runs. Under these circumstances it seems to me that these consents, which were not limited in time or dependent upon expenditure, were as much the property of the corporation before its dissolution as its physical property; that the franchises, rights, and privileges granted by the several Boards of Aldermen did not cease and determine on Jan. 1, 1907."

Standard Oil Case Thrown Out of Court.

Judge Anderson in the Federal court at Chicago on March 10 instructed the jury in the famous rebating case against the Standard Oil Company of Indiana to bring in a verdict

of "not guilty," and the verdict was returned in accordance with this instruction.

The famous case, in which at the first trial Judge Landis fixed a fine of $29,240,000, was practically thrown out of court because Judge Anderson held that counsel for the government had failed to prove that the rates of 18 cents and 19½ cents, which the government claimed were the legal rates, were ever legally fixed by the Chicago & Alton, and that therefore no illegal concession had been made to the Standard Oil Company in giving it rates of 6 and 7½ cents. In giving his instructions to the jury Judge Anderson said that he was governed entirely by the decision rendered by the United States Circuit Court of Appeals in reversing the decision of Judge Landis. He added in part:

"The government charges that the carrier had in all respects complied with the statute with regard to establishing, filing and publishing its rates, and that by that compliance with the statute it established as the rate, for illustration, between Chicago and common points and East St. Louis 18 cents per 100 lbs. It then charges that the Standard Oil Company received the concession in that it shipped at 6 cents. But the evidence does not prove the charge. The government now, as in the former trial, relied upon as establishing this 18-cent rate this tariff No. 24, and this Illinois classfication. The higher court clearly states that on the tariff sheet itself no 18-cent rate for petroleum appears and that the 18-cent rate was arrived at by a process of circumlocution, or, in other words, with the aid of, and by recourse to the Illinois classification.

"It was found," the court continued, "that petroleum and its products were set down in the 'fifth' class; and then by turning back to tariff sheet No. 24 it was found that the rate set down for the 'fifth' class was 18 cents.

"And, so out of this process of reference and cross-reference, the lawful published rate was evolved by the trial court to be 18 cents; not because it so appeared on the face of the tariff sheets, but because, by reference to other sheets—sheets fixing, not rates, but classification, and that not by the Interstate Commerce Commission or the carrier, but by the Illinois Railway Commission—it could be so figured out.

"How many nice judicial questions are raised in this case upon the accuracy and validity of the result thus arrived at. Tariff schedule No. 24, for instance, with the words thereon printed, 'Governed by Illinois classification,' took effect May 15, 1899.

"The Illinois classification that the government relies upon as adopted by reference was not adopted until nearly four months afterward, to wit, Sept. 7, 1899. No proof is in the record of the existence of any Illinois classification as of May 15, 1899, the time the tariff sheet was filed. Do the words 'governed by Illinois classification' refer to a classification in existence when the tariff was filed? If so, the proof fails, for no such classification is shown.

"Are the words to be interpreted as if they read 'governed by Illinois classification' as from time to time that classification may be changed? If so, it is only because words not expressed are to be judicially imported into the face of this tariff sheet—the clause to be so enlarged by judicial interpretation that it would be thereafter within the power of state commissions, at any time, through changes of state classifications, to alter from time to time and without consent of the interstate carriers, interstate rates for interstate commerce, unless such interstate carrier instantly reconformed its tariff sheets to the changed classification of the several state commissions.

"Indeed, taking this along with some of the other questions that have been brought to our attention in connection with these schedules, we are not prepared to say that tariff sheet No. 24 really fixes the rate on petroleum and its products at 18 cents. The most we can say is that judges after full discussion might reasonably disagree.

"The Court of Appeals have said, upon this same evidence, after having considered it in all its relations, that they cannot say that these two papers really fix any 18-cent rate.

"Therefore, gentlemen of the jury, if the Court of Appeals have so ruled, and if it is a question on which trained judges may differ, then, of course, the evidence is not sufficient to warrant you in finding that these papers establish that rate beyond a reasonable doubt."

Car Service Operations.

The monthly summary of commerce and finance of the United States for December, 1908, in making comparisons of car service operations, says:

"The figures for 1908 and for December, 1908, are subject to revision.

"Thirty-five different associations and demurrage bureaus report monthly the number of cars handled in their respective territories. Only in a very rough way, however, do these figures indicate the changes in volume of traffic, inasmuch as they do not, in some cases, include more than one-third of the cars actually handled at a given traffic center, and the territory under control of an association may be extended or contracted from time to time. The figures are given, nevertheless, as a convenient general gage of increase or decrease of traffic by rail, assuming that they are made up on substantially the same basis from year to year.

"The number of cars handled during December by 35 car-service associations and demurrage bureaus in various parts of the country, while over 16 per cent. in excess of the like number for December, 1907, shows, however, a decrease since the previous month. The total for the year, 28,278,414 cars, was 13 per cent. below the number handled during the preceding year, and even below the totals for the years 1905 and 1906.

"The latest report of the American Car-Service Association indicates a large increase in the number of idle cars of all classes and in all sections of the country, the unfavorable turn of the traffic situation appearing more clearly in the eastern industrial states. While part of this increase was to be expected after the months of the heaviest crop movement and with the passing of the holiday trade, the large increase in the number of coal, gondola and hopper cars indicates a slackening demand for coal, ore and building material.

NUMBER OF CARS HANDLED BY 35 CAR-SERVICE ASSOCIATIONS AND DEMURRAGE BUREAUS DURING DECEMBER AND TWELVE MONTHS ENDING DECEMBER, 1907-1908.

Names of Associations and Bureaus.	Month of December.		Twelve Months Ending December.	
	1907	1908	1907	1908
	Cars.	*Cars.*	*Cars.*	*Cars.*
Alabama Demurrage and Storage Bureau	44,715	60,014	779,402	631,487
Baltimore and Washington Demurrage Bureau	49,278	55,100	735,103	640,074
Central New York Car Demurrage Bureau	57,377	63,045	753,269	738,054
Central (St. Louis) Demurrage and Storage Bureau	63,107	78,769	919,130	838,017
Chicago Demurrage Bureau	159,789	214,278	2,282,191	2,161,767
Cincinnati Car Service Assn.	52,625	55,696	771,990	635,365
Cleveland Car Demurrage Bur.	69,538	63,244	1,016,003	715,764
Colorado Car Service Assn	38,910	39,490	445,900	385,260
Columbus Car Service Assn.	28,300	30,771	469,773	363,130
East Tennessee Demurrage and Storage Bureau	24,717	26,803	388,066	293,597
Indiana Car Service Assn	79,053	94,532	1,104,855	1,077,786
Intermountain Demurrage Bur.	12,776	17,426	184,577	153,885
Lake Superior Car Serv. Assn.	29,470	28,460	415,642	338,109
Louisville Car Service Assn.	32,761	46,596	506,528	518,955
Memphis Demurrage and Storage Bureau	22,068	27,778	255,169	239,156
Michigan Car Service Assn	58,414	66,275	838,928	696,926
Missabe Range Car Serv. Assn.	2,243	3,107	42,786	42,930
Missouri Valley Demurrage and Storage Bureau	139,451	142,912	1,910,139	1,606,758
Nashville Demurrage Bureau.	23,774	26,046	351,572	326,385
New York and New Jersey Car Demurrage Bureau	102,788	108,024	1,409,161	1,248,609
North Carolina Car Serv. Assn.	29,037	35,437	407,257	404,334
Northeastern Pennsylvania Car Demurrage Association	62,477	43,028	917,936	633,655
Northern Demurrage Bureau.	130,470	121,684	1,736,981	1,515,706
Pacific Car Bureau	86,854	98,382	1,166,886	1,147,345
Pacific Northwest Car S. Assn.	63,104	73,815	888,093	845,405
Phila. Car Demurrage Bur.	147,197	190,939	2,326,723	1,921,142
Pittsburg Car Demurrage Bur.	140,359	185,477	2,935,299	1,977,891
Southeastern Car Serv. Assn.	61,763	78,811	853,720	823,948
Southern Car Serv. Assn.	44,224	50,777	492,914	513,438
Texas Car Demurrage and Storage Bureau	78,571	143,908	986,475	1,118,622
Toledo Car Serv. Assn	34,055	30,839	530,617	383,870
Virginia and West Virginia Demurrage Bureau	60,129	63,644	893,905	778,940
Western and New York Car Demurrage Association	65,828	73,625	986,962	806,488
Western (Omaha) Demurrage Bureau	57,771	67,971	770,470	733,346
Wisconsin Demurrage Bureau.	73,549	86,225	1,118,720	1,022,270
Total reported by 35 associations and bureaus.*	2,226,542	2,592,928	32,593,142	28,278,414

*The Butte Terminal Association was superseded by the Montana Demurrage Bureau in May, 1908. The returns of the new bureau for December were 44,740 cars and for the seven months beginning with June, 237,825 cars.

Railroad Officers.

ELECTIONS AND APPOINTMENTS.

Executive, Financial and Legal Officers.

Edmund Pennington, General Manager of the Minneapolis, St. Paul & Sault Ste. Marie, has been elected also President, succeeding Thomas Lowry, deceased.

Harry Cotter, Assistant Claim Agent of the Toledo, St. Louis & Western, has been appointed a Claim Agent, with office at Frankfort, Ind., succeeding John Bedford, resigned.

Edward T. Nichols, the Third Vice-President, Secretary and Assistant Treasurer of the Great Northern, has been elected also the Secretary and Treasurer of the Colorado & Southern, succeeding James S. Mackie, resigned.

William McNab, President of the American Railway Engineering and Maintenance of Way Association, was born in Scotland in 1855. He is a son of the late Thomas McNab and grandson on his father's side of the late William McNab, Curator and General Superintendent of the Royal Botanic Gardens, Edinburgh, Scotland, and on his mother's side of the late James Haig Cobban, Collector of Her Majesty's Customs, Alloa, Scotland. He came to Montreal with his parents at an early age and received his education at the McGill Model School and at the Montreal Collegiate School. On graduating from the latter in 1870 he began railway work on the Grand Trunk as an indentured pupil in the Engineering department, and has since been continuously connected with that road. From 1870 to 1875 he was engaged with the Chief Engineer upon detail matters connected with the works of the International bridge, then in course of construction across the Niagara river between Buffalo, N. Y., and Ft. Erie, Ont.; on the location and construction of the Lewiston & Auburn Railroad in Maine, including its bridgework; the construction of the union station buildings and general terminal facilities at Toronto, and the erecting and machine shops at Stratford, Ont. He also tended the various works connected with the renewal in iron of all the large Howe truss bridges on the road; the construction of the new train ferry docks at Point Edward, Ont., and Ft. Gratiot, Mich., and the methods adopted for and practical work in narrowing the old broad gage roadbed to the present standard gage. From 1875 to 1885, after having passed an examination before the Province of Quebec Board of Examiners for the study of land surveying, he was engaged for several years almost exclusively upon Grand Trunk surveys, acting as Engineer of Surveys and Levels on upwards of 400 miles of Grand Trunk lines for projected recision work; as Engineer of Construction of double-tracking between Scarborough, Ont., and Toronto, and of the York Yard terminals and engine houses and Engineer of Location and Construction of portions of lines in Michigan and Provinces of Ontario and Quebec, now merged into the Grand Trunk System. Between 1886 and 1896 he had charge of general engineering work and maintenance of way, including control of construction of the terminal station at Montreal, the subway under the freight and terminal yards, Wellington street, Montreal; Back Cove drawbridge and approaches, Portland, Me., and the design and construction of masonry and other general structures. From 1896 to 1907 he superintended the drafting room and assisted the Chief Engineer in various new works, including the replacing of the single-track Victoria iron tubular bridge across the St. Lawrence river at Montreal by the present double-track steel trusses. In 1907 he was appointed Principal Assistant Engineer of the entire system. He is a member of the American Society of Civil Engineers as well as of the Canadian Railway Club and the Canadian Society of Civil Engineers. He was a member of the Council of the latter body in 1903 and in 1907, and is at present chairman of its committee on transportation routes. He is a charter member of the American Railway Engineering and Maintenance of Way Association, and in this connection was the first Vice-Chairman of the committee on graduation (afterwards roadway), becoming Chairman in 1902. In 1904 he was appointed Chairman of a new committee, that on economics of railway location, and in 1905 was elected a Director of the association. In 1907 he was elected Second Vice-President of the association, and in the same year succeeded to the office of President made vacant by the death of the late Walter G. Berg.

Operating Officers.

James H. Burke has been appointed the Superintendent of the Northern Railway of Costa Rica, with office at San Jose, Costa Rica, succeeding W. D. Danley, resigned.

H. J. Roth has been appointed the Assistant Superintendent of the Wyoming division of the Union Pacific, with office at Cheyenne, Wyo., succeeding W. C. McKeown, promoted.

C. W. Martyn has been appointed the Assistant Superintendent of the Southern Pacific Lines in Oregon, with office at Portland, Ore., succeeding G. C. Morris, resigned to engage in other business.

Guy Adams, the Supervisor of Mails of the Chicago, Rock Island & Pacific, the Chicago & Eastern Illinois and the Evansville & Terre Haute, has been appointed also the Supervisor of Mails of the St. Louis & San Francisco, with office at St. Louis, Mo., succeeding T. J. Franks, General Agent, resigned.

George Geiger, the Superintendent of the Red River division of the St. Louis & San Francisco, has resigned. M. A. Gossette, the Assistant Superintendent, has been made Chief Despatcher, with office at Francis, Okla., succeeding J. P. Lathrop, appointed a Despatcher. J. F. Hickey, Assistant Superintendent at Hugo, Okla., has been transferred to Francis, Okla., succeeding Mr. Gossette, and H. E. Gabriel, the Assistant Superintendent at Ft. Smith, Ark., succeeds Mr. Hickey. These changes were made necessary on account of the abolition of the Red River division, as announced in the *Railroad Age Gazette* of March 12.

Charles W. Kouns, as previously announced in these columns, has been appointed the General Manager of the Western Lines of the Atchison, Topeka & Santa Fe, with office at Amarillo, Tex. He will have charge of the Western, Arkansas, River, Colorado, New Mexico, Rio Grande and Panhandle divisions, including about 3,200 miles of track. He was born October 22, 1854, at New Holland, Ohio. He began railway work in 1871 as a telegraph operator on the Kansas Pacific, now a part of the Union Pacific. In 1873 he was made a Train Despatcher on the same road, and in 1876 was appointed Train Despatcher of the International & Great Northern. In 1877 he was made chief clerk to the Master of Transportation of the Galveston, Harrisburg & San Antonio. From 1877 to 1880, he was a freight conductor, Chief Train Despatcher and Trainmaster of the International & Great Northern. In 1880 he was appointed Train Despatcher of the Eastern division of the Missouri Pacific and in 1881 he returned to the International & Great Northern as Trainmaster. In 1883 he was appointed Master of Transportation of the Galveston, Harrisburg & San Antonio, and in 1885 was made Division Superintendent of the Union Pacific. In 1888 he was appointed Superintendent of Transportation of the Atchison, Topeka & Santa Fe, and in 1907 was made Assistant to the Second Vice-President, which position he held until his recent promotion.

C. W. Kouns

Carl Henry Stengel, whose appointment as the Superintendent of Coal Terminals of the Virginian Railway has been previously announced in these columns, was born September 13, 1879, at Yonkers, N. Y. Attending Cooper Institute in the evenings, he took a five-year course from 1897 to 1902, and received the degrees of Bachelor of Science and C. E.

When he was 15 he worked as axman for the city surveyor of Yonkers, and in 1896 became instrument man on public works in Yonkers. Two years later he became draftsman for a paper mill works, and later was promoted to General Designing Engineer, doing all the designing of steel and machine work. In 1901 he was appointed Assistant Engineer in the Structural Engineering department of the Cambria Steel Works. He began railway work in 1902 as draftsman on the New York Central & Hudson River, later being promoted to Assistant Designing Engineer, having charge of the design for the foundation work of the Yonkers power station. In 1905 he was made Designing Engineer on the Virginian Railway, where beside his other work he designed plans for the Sewells Point terminals. He held this position until his present appointment.

Traffic Officers.

A. C. Braun has been appointed a Traveling Freight Agent of the Cleveland, Cincinnati, Chicago & St. Louis, with office at Dayton, Ohio.

W. J. Dibble has been appointed a Traveling Freight Agent of the Elgin, Joliet & Eastern, succeeding Charles D. Dibble, resigned to go into other business.

W. R. Johnston has been appointed a Commercial Agent of the Gulf Line Railway, with office at Sylvester, Ga., reporting to the Vice-President and Traffic Manager.

G. S. Pentecost has been appointed a Division Passenger Agent of the Chicago, Rock Island & Pacific, with office at Omaha, Neb., succeeding F. P. Rutherford, assigned to other duties.

C. D. Wayne, Assistant General Passenger Agent of the Seaboard Air Line, with office at Portsmouth, Ga., has been transferred as Assistant General Passenger Agent to Atlanta, Ga., succeeding J. J. Puller, resigned.

C. W. Colby has been appointed the General Pacific Coast Agent of the Erie, with office at 36 Ellis street, San Francisco, Cal. He will be in charge of freight and passenger traffic of the states of California, Oregon, Washington, of the territory of Arizona, of British Columbia, Alaska, and of that portion of the state of Nevada east of Battle Mountain and Las Vegas.

D. M. Denison, Commercial Agent of the Minneapolis & St. Louis and the Iowa Central, has been appointed an Assistant General Freight Agent, with offices at Minneapolis, Minn., succeeding H. F. Marsh, resigned to engage in other business. E. O. Eckhart, Commercial Agent, succeeds Mr. Denison, with office at Minneapolis. M. J. Hannam, Commercial Agent, succeeds Mr. Eckhart, with office at St. Paul, Minn. H. T. Boyd succeeds Mr. Hannam, with office at Des Moines, Iowa.

Engineering and Rolling Stock Officers.

G. W. Robb has been appointed an Assistant Master Mechanic of the Grand Trunk Pacific, with office at Rivers, Man.

W. C. Weigel has been appointed the General Time and Work Inspector of the Motive Power Department of the Union Pacific, with office at Omaha, Neb.

W. H. Wells, Engineer of Construction of the Southern Railway, has been appointed the Chief Engineer of Construction, with office at Washington, D. C., and his former office has been abolished.

Euclid E. Grist, Assistant General Foreman of the Ft. Wayne, Ind., shops of the Pennsylvania Lines West, has been appointed an Assistant Master Mechanic, with office at Ft. Wayne. Allen S. Courtney succeeds Mr. Grist.

Purchasing Officers.

E. V. Dexter, Purchasing Agent of the Mexican Central, has resigned, and all purchasing and sales for account of the National Railways of Mexico will in future be done by J. H. Guess, Purchasing and Fuel Agent, with office at Mexico City. Carl Holt Smith has been appointed the Assistant Purchasing Agent of the National Railways of Mexico and of the Mexican International and the Interoceanic of Mexico, with office at Mexico City, and will report to the Purchasing and Fuel Agent.

OBITUARY.

John W. Sharp, Superintendent of the Rochester division of the Erie, died the early part of last week from injuries resulting from being struck by a trolley car.

John Butterfield died at his home in Utica, N. Y., on March 9. He was 82 years old and was one of the party of seven who established the first overland mail route to the Pacific coast in 1858.

General William J. Palmer, formerly President of the Denver & Rio Grande and of the Mexican National, a hero of the civil war, a pioneer of Colorado and a prince of philanthropy, died at his home in Colorado Springs March 13, at the age of 72.

Alfred B. Farnsworth, formerly General Eastern Passenger Agent of the Chicago, Rock Island & Pacific, with office in New York, died in Grand Rapids, Mich., March 7. A few years ago Mr. Farnsworth retired from active business because of failing health, and at the time of his death was living in Grand Rapids, Mich. He leaves a wife and one daughter, Mrs. H. H. Atkinson.

Railroad Financial News.

MAINE CENTRAL.—Bond & Goodwin have bought from the company $2,000,000 4 per cent. debenture notes of March 1, 1914. The proceeds of the sale are to be used by the Maine Central to refund about $1,000,000 notes maturing this year and for other purposes.

MINNEAPOLIS, ST. PAUL & SAULT STE. MARIE.—The stockholders are to vote on April 10 on the lease of the Wisconsin Central under terms already approved by the directors.

The directors have authorized $6,148,000 new stock, one-third to be preferred and two-thirds common. The stock is to be offered at par to stockholders. There is now $16,800,000 common stock outstanding and $8,400,000 preferred stock. The common stock was selling at about 144 on the New York Stock Exchange last week and the preferred stock at 154 to 157.

Horace Lowry has been elected a director, succeeding Thomas Lowry, deceased. (See Wisconsin Central.)

MOBILE, JACKSON & KANSAS CITY.—See New Orleans, Mobile & Chicago.

NEW ORLEANS, MOBILE & CHICAGO.—The plan for the reorganization of the Mobile, Jackson & Kansas City and the Gulf & Chicago formulated in 1907 and modified in October, 1908, has become operative. The new company, the New Orleans, Mobile & Chicago, is to issue the following: Fifty-year 5 per cent. bonds secured by mortgage on the property and limited to $30,000 per mile of completed road; $5,000,000 6 per cent. non-cumulative preferred stock and $11,500,000 common stock.

NEW YORK STATE RAILWAYS.—The consolidation of the Rochester Railway, the Rochester & Eastern Rapid Transit and the Sodus Bay Railway under the name of the New York State Railways has been approved by the New York Public Service Commission, Second district. (Jan. 8, page 90.)

NORTHWESTERN ELEVATED (CHICAGO).—The committee of three in charge of negotiations for the consolidation of the elevated roads in Chicago, and the committee of five representing the Metropolitan West Side Elevated, say that all the roads have given tentative approval to the plan which provides for the formation of a central company, which is to purchase the Union loop, now owned by the Northwestern Elevated and said to be worth about $8,000,000. The central company is then to lease the other lines, agreeing to pay the stockholders of the latter fixed dividends, possibly on a sliding scale, based on the earnings of the respective roads. Expert accountants have been set to work on the books of most of the roads to secure the figures on which the arrangement may be worked out by the promoting committee.

ROCHESTER & EASTERN RAPID TRANSIT.—See New York State Railways.

Rochester Railway.—See New York State Railways.

Sodus Bay Railway.—See New York State Railways.

Union Pacific.—The company has reconveyed to the United States, it is reported, about 4,560 acres of coal lands in Wyoming valued at about $10,000,000, thus settling out of court the suit brought by the government involving ownership of these lands.

Washington, Baltimore & Annapolis.—The interest due March 1 on the first mortgage bonds of the Baltimore Terminal Co., which are guaranteed principal and interest by the Washington, Baltimore & Annapolis, was not paid. There are outstanding $1,992,000 first mortgage Baltimore Terminal bonds, of which about $600,000 are used for collateral purposes, and the interest on the bonds used for collateral purposes, it is said, does not have to be paid.

Wisconsin Central.—The directors on March 11 authorized a refunding first mortgage securing bonds not to exceed $60,000,000, of which $36,000,000 is to be reserved for refunding and the remainder to be issued during the next 50 years.

The stockholders on April 13 are to vote on the proposition to lease the property to the Minneapolis, St. Paul & Sault Ste. Marie for 99 years. (See Minneapolis, St. Paul & Sault Ste. Marie.)

Equipment and Supplies.

LOCOMOTIVE BUILDING.

The Duluth & Northern Minnesota has ordered one locomotive from the Baldwin Locomotive Works.

The Acme, Red River & Northern has ordered one locomotive from the Baldwin Locomotive Works.

CAR BUILDING.

The Chicago, Burlington & Quincy is in the market for 10 tank cars.

The Southern is asking prices on 114 passenger cars of different types.

The American Smelters Security Co., Ely, Nev., has ordered 100 sixty-ton steel ore cars from the Ingoldsby Automatic Car Co. They will be 27 ft. 6 in. long over end sills and weigh about 38,000 lbs.

The Cleveland Furnace Co., Cleveland, Ohio, has ordered 4 sixty-ton steel ore cars from the Ingoldsby Automatic Car Co. They will be 27 ft. 6 in. long over end sills and will weigh about 38,000 lbs.

The Delaware, Lackawanna & Western, reported in the *Railroad Age Gazette* of February 12 as having ordered 40 locomotives from the American Locomotive Co., has divided this order as follows: One eight-wheel switch, nine Mogul for fast freight service, 18 consolidation, 10 six-wheel switch, and two Mogul for pusher service.

General Dimensions.

	8-wheel switch.	Mogul freight.	Consolidation.
Number	1	9	18
Weight on drivers	201,000 lbs.	150,000 lbs.	167,500 lbs.
Total weight	201,000 "	171,000 "	188,000 "
Cylinders	22 in. x 28 in.	22½ x 26 in.	21 in. x 26 in.
Diameter of drivers	57 in	63 in.	57 in.
Boiler, type	Wagon top.	Straight top.	Straight top.
" wkg. steam pressure	200 lbs.	200 lbs.	200 lbs.
Heating surface, tubes	2,836 sq. ft.	2,191 sq. ft.	2,589 sq. ft.
" " firebox	190 "	167 "	174 "
" " total	3,026 "	2,358 "	2,763 "
Tubes, number	379	310	341
" outside diameter	2 in.	2 in.	2 in.
" length	14 ft. 3½ in.	13 ft. 6 in.	14 ft. 6 in.
" material	Steel.	Steel.	Steel.
Firebox, type	Semi-wide.	Semi-wide.	Semi-wide.
" length	9 ft. 3⅝ in.	8 ft. 6 in.	8 ft. 6 in.
" width	6 ft. 3 in.	6 ft. 3 in.	6 ft. 3 in.
" material	Steel.	Steel.	Steel.
" maker	Carbon steel Co.	Carbon Steel Co.	Carbon Steel Co.
Grate area	58 sq. ft.	53.4 sq. ft.	53.4 sq. ft.
Tank capacity	60,000 gals.	7,000 gals.	7,000 gals.
Coal capacity	10,000 tons.	10,000 tons.	10,000 tons.
Tractive effort	40,400 lbs.	29,484 lbs.	34,200 lbs.

	Six-wheel switch.	Mogul, pusher service.
Number	10	2
Weight on drivers	132,000 lbs.	150,000 lbs.
Total weight	132,000 "	171,000 "
Cylinders	19 in. x 24 in.	21 in. x 26 in.
Diameter of drivers	15 in.	57 in.
Boiler, type	Straight top.	Straight top.
Boiler, wkg. steam press.	180 lbs.	200 lbs.
Heating surface, tubes	1,690 sq. ft.	2,410 sq. ft.
" " firebox	164 "	168 "
" " total	1,854 "	2,578 "
Tubes, number	269	341
" outside diameter	2 in.	2 in.
" length	12 ft.	13 ft. 6 in.
" material	Steel.	Steel.
Firebox, type	Semi-wide.	Semi-wide.
" length	7 ft. 6 in.	8 ft. 6 in.
" wide	6 ft. 3 in.	6 ft. 3 in.
" material	Steel.	Steel.
" maker	Carbon Steel Co.	Carbon Steel Co.
Grate area	46.3 sq. ft.	53.4 sq. ft.
Tank capacity	3,300 gals.	6,000 gals.
Coal capacity	6 tons.	10 tons.
Tractive effort	25,992 lbs.	34,200 lbs.

Special Equipment.

Axles	Midvale
Bell ringer	Snow
Boiler lagging	Sectional magnesia; Johns-Manville or Franklin
Brakes	Westinghouse-American E. T. No. 6
Brake-shoes	Perfecto
Couplers	Gould cast-steel, 5 x 7 in. shank
Driving boxes	Cast steel
Grease cellars on driving box	(2) 16-in. Dressel
Inspirator	No. 11 Hancock composite
Journal bearings	Magnus
Piston and valve rod packings	United States
Safety valve	(2) 3-in. Consolidated
Sanding devices	Leech Air and Hand
Lubricators	Nathan B. E. No. 9
Springs	Cast steel, D., L. & W. specifications
Steam gages	Ashcroft
Staying	Tate flexible in breaking zone
Tires	Midvale
Tender journal boxes	Symington
Tender draft gear	Session friction Acme coupling device

IRON AND STEEL.

The Great Northern is in the market for 2,000 tons of structural steel.

The Atchison, Topeka & Santa Fe has ordered 5,000 tons of tie plates from the Illinois Steel Co.

The Chicago Railways Co. is in the market for about 500 tons of structural steel for building new car barns.

The Northern Pacific is in the market for from 3,000 to 5,000 tons of structural steel for bridge construction.

The Chicago & North Western is in the market for 11,000 tons of structural steel for track elevation work.

The Chicago, Milwaukee & St. Paul has ordered 300 tons of plate girder construction from the Wisconsin Bridge & Iron Co. and will place an order soon for an additional 600 tons.

General Conditions in Steel.—Recent reports indicate that a continuation of the present price war and underbidding by the United States Steel Corporation will work a hardship on some of the independent companies, and it is even intimated that shutdowns may result. An officer of one of these independent companies is quoted as having said that the corporation has gotten practically all of the large orders for structural steel recently placed. The independents are said to be bidding as low as possible without operating at a loss, and that unless there is some improvement in the near future, material changes in wage scales will result. The price of rails is yet maintained, and although there is some slight feeling of a reduction, nothing definite has yet resulted.

RAILROAD STRUCTURES.

Garrett, Ind.—Local reports are that the Baltimore & Ohio is preparing to build a new roundhouse during the coming spring.

New Orleans, La.—The St. Louis & San Francisco and the Southern have petitioned the City Council for a franchise for a new passenger station to replace their present structure. It is proposed to erect a structure extending from the lake side of Basin street to North Rampart street and either 10 or 12 stories high.

SEATTLE, WASH.—The Hurley-Mason Co., of Tacoma, Wash., has been given the contract for the concrete piling and foundation for the new passenger station of the Union Pacific to be located between Jackson and King streets and Fourth and Fifth avenues south. The foundation work will cost about $40,000 and will involve driving concrete piling to a depth of 38 ft.

TACOMA, WASH.—The Chicago, Milwaukee & Puget Sound, according to press reports from Tacoma, has announced that car building and car repairing shops will be erected on the tide flats near its terminal holdings. It is stated that the shops will be almost as large as those at Milwaukee and will be equipped to provide facilities for the western lines.

VICTORIA HARBOR, ONT.—The Canadian Pacific has given the contract for a grain elevator to John S. Metcalf, 184 La Salle street, Chicago. It is estimated it will cost $750,000.

WICHITA, KAN.—The Atchison, Topeka & Santa Fe has completed plans for the new passenger station which is to replace the present structure. It will be of terra cotta construction, one-story high and will have dimensions of 222 ft. x 60 ft. The interior will be finished in tiling with cement floors. The general waiting room will have a floor space of 4,000 sq. ft.; two waiting rooms each 23 ft. x 36 ft. and baggage room 46 ft. x 59 ft. Work upon this structure will begin in a few days.

SIGNALING.

In the Union Switch & Signal Company's Long Island order, referred to in our issue of March 12, inductive bonds will be used, the system being essentially the same as that installed by the Union on the New York, New Haven & Hartford from Vernon to East Hartford, and described in the *Railroad Gazette* January 17, 1908; that is, not only will the track circuits be alternating current, but the operation of the motors and the slot magnets and the lighting of the signals will be alternating current also. This system has worked with practically perfect success on the line from Vernon to East Hartford, and with small power consumption. The Long Island contract was awarded the afternoon of Saturday, March 6, with the stipulation that the signals shall be installed, tested and ready for regular operation May 15. There will be 31 block sections.

Supply Trade News.

F. W. Boldrick, Representative of the Hofius Steel & Equipment Co., at Spokane, Wash., has been appointed Representative of E. P. Jamison & Co., of Seattle, Wash., with office in the Fernwell building, Spokane.

Henry M. Steele, for the past few years Chief Civil Engineer for J. G. White & Co., Engineers and Constructors, New York, has resigned on account of ill health and has moved with his family from New York to Asheville, N. C.

The Grant Locomotive & Car Works, Inc., Houston, Tex., is the new name of the company formerly known as the Grant Iron Works. The business of the company is repairing and rebuilding locomotives and cars. A department has been added recently for manufacturing steam and electric railway frogs, crossings and switches. It is the intention of the company to eventually add facilities for the building of new cars.

A third and final decision after a four years' contest has just been rendered in the patent office by the Commissioner of Patents on appeal in favor of Edward E. Gold, President of the Gold Car Heating & Lighting Co., New York. The patent relates to the "impositive lock" which forms part of the Gold hose coupler. This lock is an automatic device which prevents uncoupling but yields when the cars pull apart, permitting the couplers to uncouple automatically.

The Pitts Foundry & Contracting Co., South Houston, Tex., has recently been organized to manufacture railway and machine castings. A new foundry is being erected, consisting of a main building 80 ft. x 125 ft., with cupola house, core house, core ovens, pattern shops and a building for tumbling and cleaning castings. The foundry will be equipped with a 15-ton traveling crane and five 2-ton trolleys. It is expected that the plant will be in operation about April 1. L. A. Pitts is President.

The Barrett Manufacturing Co., New York, is exhibiting at the Coliseum this week something new in waterproofing, it being the use of a bituminous binder protection over the waterproofing course in overhead bridges. A new system of floor construction is also a feature of the exhibit. It is for use where a wooden floor is required directly on the ground without air space beneath. This construction protects the floor against the ground dampness and results in a wooden lower floor lasting as long as any other part of the building.

The annual meeting of the stockholders of the Union Switch & Signal Co., Swissvale, Pa., was held on March 9. Owing to the absence in Europe of George Westinghouse, President, H. G. Prout, Vice-President of the company, acted as chairman. The following were elected as directors: George Westinghouse, Robert Pitcairn, William McConway, George C. Smith, Thomas Rodd, H. G. Prout and James J. Donnell. At the close of the meeting the representative of the company said that there is at the present time orders on hand at Swissvale amounting to $1,357,000.

The American Concrete Co., Chicago, is exhibiting at the Road & Track Supply Association, held at the Coliseum this week, a full size section of a reinforced concrete culvert pipe which is 8 ft. long and 48 in. in diameter. This pipe is being made in smaller sizes also and has been adopted by the Chicago, Burlington & Quincy as standard. A reinforced concrete pile trestle, shown by a model, is new insofar as the concrete piles are concerned. The pile used is patented by A. C. Chenoweth, Brooklyn, N. Y. It is fabricated instead of being moulded, thereby giving it a mesh reinforcement practically on the outside of the pile, which adds to its strength as a column.

Burton W. Mudge & Brother, Chicago, have been appointed Western Representatives of the McInnes Steel Co., Corry, Pa. This company manufactures a complete line of tool steels, including steels in all tempers for chisels, drills and cold sets; "Cello" oil hardened steel for dies, taps, reamers and special tools; "Extra" high-speed steel for locomotive tire lathes; annealed steel for dies, taps and reamers and special lathe tool steels. The Western Machinists' Supply Co., Minneapolis, Minn., of which L. R. Roy is President, will represent the McInnes company in the Northwest, and the National Steel Co., Pittsburgh, will attend to that district. The Eastern representatives are Schrock & Squires, New York.

The National Lock Washer Co., Newark, N. J., report among recent orders: Curtain fixtures for the eight passenger coaches recently ordered by the Virginian Railway; sash balance and curtain fixture specified for use on the four cafe and club cars to be built for this road; sash lock, sash balance and curtain fixture specified for the five passenger coaches and two passenger and baggage combination cars recently ordered by the Seaboard Air Line; curtain fixture for the 12 coaches building for the Carolina, Clinchfield & Ohio Railway; curtain fixture specified for the 15 new coaches building for the Central Railroad of New Jersey; curtain fixture and sash lock for over 300 cars rebuilding for the Philadelphia Rapid Transit Co., and curtain fixture for the 200 odd cars building for the Third Avenue Railway, New York.

The gross sales of the Pressed Steel Car Co., Pittsburgh, Pa., for the year ended December 31, 1908, were $8,589,422 as compared with gross sales of $36,443,304 in 1907. Of the sales in 1908, over 70 per cent. of the amount was sold during the first three months. The falling off in gross sales was caused by a great reduction in the purchasing power of the railways resulting from the general business depression and from adverse legislation which forced the most rigid economy. The net profits for the 1908 year amounted to $265,478 and in 1907 the net profits were $2,907,920. There was very little change in the assets and liabilities of the company as represented by the value of property and franchises and securities outstanding or in the securities owned. In current assets, however, accounts receivable were reduced from $4,172,653 in 1907 to $668,105 in 1908, and stock of materials on hand from $3,500,154 to $246,510. The supply of cash in banks

was increased from $1,733,487 to $2,837,990; thus current assets decreased from $9,406,293 in 1907 to $3,752,604. At the same time current liabilities decreased from $5,012,488 to $446,301. For instance, accounts payable in 1907 amounted to $3,770,611 and in 1908 to but $169,532. The company anticipating that there would be large cash balances which would not be required in the business, paid in August, 1908, the eighth annual installment of $500,000 on the notes secured by mortgage. This leaves but $1,000,000 unpaid on these notes, due $500,000 February 1, 1910, and $500,000 February 1, 1911. For the first time the steel passenger car department contributed to earnings, and business booked for next year indicates a continuance of revenue from this source. There was spent for improvements and betterments $283,516, and charged to properties and franchises.

TRADE PUBLICATIONS.

High-Tension Magnetoes.—The Hess-Bright Manufacturing Co., Philadelphia, Pa., are mailing an article on high-tension magnetoes, which is a reprint from one which appeared in the *Cycle and Automobile Trade Journal.*

Telephones.—The Western Electric Co., New York, are mailing a small pamphlet containing six half-tone reproductions of photographs of President Taft using a Western electric telephone in receiving the news of his election.

Locomotive and Car Shops.—The Arnold Company, Chicago, are mailing a postal card showing a general view of the locomotive and car repair shops of the Frisco Car & Engine Co., at Springfield, Mo., construction of which was recently resumed.

Compressors.—The Ingersoll-Rand Co., New York, in Form No. 3011, illustrate and describe Imperial, Type X, duplex steam-driven compressors. This is a standard loose-leaf pamphlet, 6 in. x 9 in., suitable for binding and loose-leaf cover.

Excavator.—The Heyworth-Newman excavator is described in a pamphlet recently issued by James O. Heyworth, Harvester building, Chicago. This is a drag-line bucket excavator capable of handling various materials and has a large digging radius.

Grand Trunk Pacific.—A booklet giving information regarding the western terminus of the Grand Trunk Pacific at Prince Rupert, B. C., has recently been issued. The railway has acquired 24,000 acres of land at Prince Rupert and vicinity for the purpose of a townsite and the development of the port and the first subdivision of this, including about 2,000 acres, will be sold about May 1. Full particulars and a copy of the booklet may be obtained from the Secretary of the road at Montreal, Que.

Strauss Bascule Bridges Completed During the Past Year.

During the past year there have been completed and put in service seven Strauss bascule bridges. The most notable of these is the Kinzie street bridge for the Chicago & North Western, Chicago,—the largest and heaviest double track, single leaf bascule in the world, with an average of 1,000 bridge movements a month and 300 train movements a day. This bridge was described in the *Railroad Age Gazette,* December 18, 1908.

Another notable structure is the Knippels bridge at Copenhagen, Denmark, the design for which was selected in international competition and which was dedicated with elaborate ceremonies on the first of the year. A similar bridge to the one at Copenhagen is the Federal street bridge, at Camden, N. J.

A unique design has just been completed for the Ohio Electric Railway, over Swan creek at Toledo, Ohio. It comprises a series of three plate girder spans. The bascule portion is nothing more than an independent lifting truss attached to a pair of plate girders.

The Benson street bridge of the Miami & Erie canal at Lockland, Ohio, is as broad as it is long, being 60 ft. each way. There is no operator's house for this structure, the movement of the bridge being directed from a motorman's box fixed to one of the end posts.

The Lazaretto road bridge over Darby creek, in Delaware county, Pa., is a small double leaf bridge of the underneath-counterweight type. This bridge comprises four deck plate girder spans, paved with brick, and is of unusually substantial construction.

The South First street bridge, Elizabeth, N. J., is a semi-through span with overhead counterweight, similar to the bridge for the New Jersey Shore Line Railway at Rahway, N. J., not far distant.

There are a number of additional Strauss bridges under construction, the most important being the Polk street bridge for the city of Chicago and the Walnut street bridge for the city of Green Bay, Wis.

The performance of all these bridges is reported to be most satisfactory. The Wheeling & Lake Erie bridge, at Cleveland, Ohio, after 3½ years of service, is working most smoothly. A comparison of this bridge with the Kinzie street structure brings out the marked advance made in simplifying and concentrating the Strauss design. The bridges are designed and built by the Strauss Bascule & Concrete Bridge Co., Chicago.

Eureka Continuous Crossing.

One of the chief features of the Eureka continuous crossing, illustrations of which are given herewith, is the solid cast steel bed plate with the anti-skid devices which hold every part of the crossing rigid and prevent displacement through creeping of the rails. The illustrations show clearly the method of maintaining a continuous rail in either direction. The operating mechanism, consisting of number of levers, is also shown in Fig. 2, and Fig. 1 shows the method of protecting mechanism from injury. The rails are moved through these levers and locked in position, being moved from the tower only. The manufacturers claim that this continuous rail, which does away with the severe hammer blow to locomotives and cars when passing over the flange openings of a solid crossing, affords a saving in spring hangers on locomotives and arch bars on cars sufficient to cover cost of the crossing. In the case of one of these installations which has

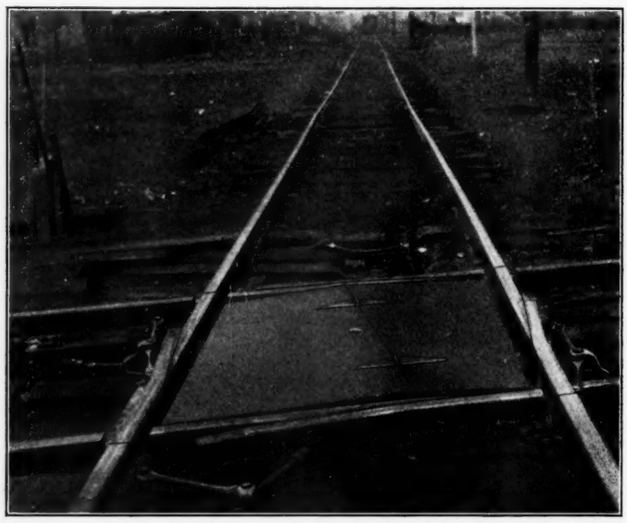


Fig. 1—Eureka Continuous Crossing Set for North and South Line.

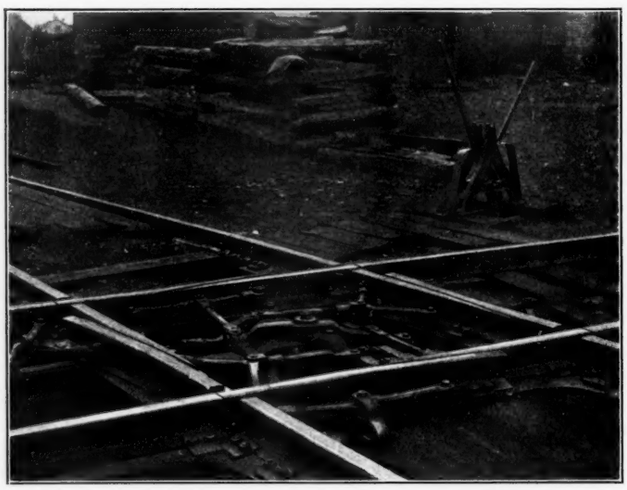


Fig. 2—Eureka Crossing Set for East and West Line.

been in track for over a year and exposed to snow, rain and sleet, it is said that it has never ceased working, nor has it been necessary to make any adjustment or to tighten or loosen any of the nuts. This crossing is thrown with less effort than that necessary for an ordinary switchstand. The following are particular features of this continuous rail crossing: Suitable for high speed usage; a life equal to that of any of the other rails in the track; maintaining its position, and eliminating the hammer blows of engines and cars.

A track foreman of an eastern road, on which one of these crossings is now in service, is quoted as having said that the slip rail is as great an improvement over the solid crossing as the point switch is over the old time stub switch, and that as the crossing is simple it will be easily maintained, since it is required to withstand no hammer blows from passing locomotives and cars.

Q. & C. Anti-Rail Creepers.

In the accompanying cuts are shown six different designs of anti-rail creepers. Fig. 1 shows the Racine No. 1, which is made with two malleable iron castings in the form of jaws which engage the lower flange of the rail. These jaws are drawn tight against the rail with one bolt, fastened with a nut lock. The creepers extend below the rail and brace against the tie. Corrugated pieces of metal in the jaws bite the rail when the bolt is tightened. This design is made to fit any size of rail by using different lengths of

Fig. 1.

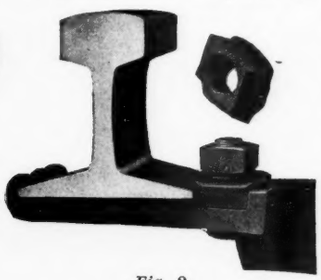


Fig. 2.

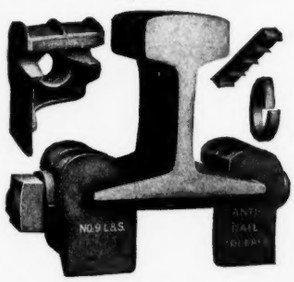


Fig. 3.

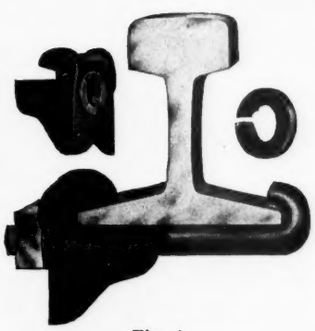


Fig. 4.

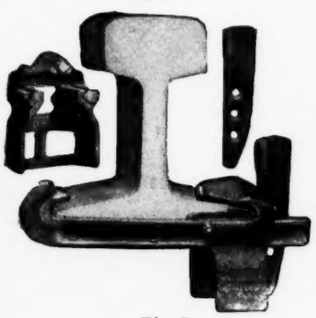


Fig. 5.

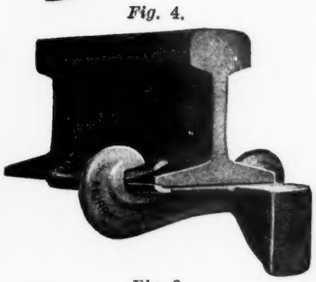


Fig. 6.

Q. & C. Anti-Rail Creepers.

the bolt. It will fit either right or left hand rail. Fig. 2, the L. & S., No. 4, is a design which is especially recommended for use with new rails. It is heavy and very strong. Fig. 3, the L. & S., No. 9, shows a design which has hard iron or steel wedges inserted in the upper jaw of the two depending lugs. These wedges engage the top of the base plate of the rail, and prevent the device from slipping. The wedges are of harder metal than the rail and will therefore bite into it. Fig. 4 shows an adjustable creeper which is made in one malleable casting either right or left. Fig. 5 shows the "Bull Dog Grip," which has knife-shaped edges which grip the rail. It is made in three pieces with no bolts, securely fastened to the rail by use of the wedge which supports the upper jaw. Fig. 6 show the Murray anti-rail creeper which is said to be a very strong device, using no bolts or nuts. These anti-rail creepers are being put on the market by the Q. & C. Co., New York.

Buffalo Railway Ratchet Wrench.

The railway ratchet wrench shown in the accompanying illustration is designed for track work on steam and electric railways and made to withstand rough usage. The wearing parts and ratchet mechanism are heavy and hardened to insure long life and minimum wear. This tool is simple in construction, of few parts, and with the ratchet mechanism enclosed so that it will not become clogged with dirt, snow or ice. The socket projects on either side of the head, and for reversing it is only necessary to turn the wrench over, as one side is used for tightening and the other side for loosening a nut. This wrench

Buffalo Railway Ratchet Wrench.

is designed to enable the workmen to accomplish a large amount of work in a short time. The wrench is made in sizes to fit standard square or hexagon nuts, including ¾-in., ⅞-in., 1-in. and 1⅛-in. This track wrench is made with a handle 30 in. long. Small ratchet wrenches, designed to fit standard square or hexagon nuts from ¼-in. to 1-in., and adapted for automobile, pulley and general use, are from 6 in. to 15 in. long. These wrenches are made by the Buffalo Railway Wrench Co., Buffalo, N. Y.

Interstate Railway Pile Drivers.

The illustrations reproduced herewith show types of railway pile drivers designed for strength, stability and simplicity. Provision has also been made for making rapid and economical repairs, every part of the machine being easily accessible. The entire machine is made of steel with the exception of the wood used in th operator's cab.

As seen in Fig. 1, the driver is mounted on a steel car. The superstructure, which rests upon the turntable, can be revolved through the entire circle. This permits driving the pile at a distance of 30 ft. 2½ in. from the center of the truck as shown in Fig. 2. The greater number of piles are driven from that end of the car farthest from the turntable, and the maximum distance available in this direction is 8 ft. 2½ in. from the center of the truck to the center of the pile. By rotating the turntable and bringing the pile driver leads to a position at the other end of the car, it is possible to drive piles at a distance of 19 ft. 2½ in. from the center of the nearest truck. This is at a greater distance than is necessary for one standard bent.

All operations, such as propelling the machine, rotating the superstructure, raising and lowering the leads and driving the piles are power controlled. This machine is said to exert a high tractive effort, and in reality to be a work-train locomotive as well as a pile driver. The steel leads are 40 ft. long, built of steel channels and plates rigidly fastened together. The back braces are angle struts strongly made, and a ladder is provided for convenient access to the top of the leaders. When lowered no part of the leaders project beyond the main body of the car, and although long and very heavy they are raised and lowered with safety by power under control of the operator. About two minutes time is said to be required for bringing the machine to position for driving.

The circular rack upon which the superstructure rotates is a massive steel casting securely fastened to the car, and it forms a circular track for the rotating pinion. This rack is mounted upon a vertical shaft connecting with the mechanism on the turntable. The rack is of large diameter to give stability when rotating and the turntable is mounted upon eight rollers. These rollers are of a self-oiling type, bronze bushed, and backed by bronze washers. The turntable supporting the superstructure is of heavy steel construction, thoroughly stiffened by cross members, and has 15-in.-channel side sills. The propelling power is supplied to the rear radial trucks. This point in design is said to be unique on account of the difficulty which has obtained in applying a simple and positive drive on radial trucks. In this machine the power is carried from the propelling mechanism down through a vertical shaft, which transmits the power through beveled gears to a horizontal shaft on the rear truck and under the car body. A spur gear, mounted on the horizontal shaft, meshes with the slightly curved face spur gear on the nearest truck axle, and the truck and gear are made extra heavy to provide for excessive bending. The curved face gear is cast in halves for ready mounting upon the track axle, and this relieves any binding tendency when rounding curves upon the truck axle. This design does away with the necessity of having a system of universal joints. The propelling mechanism under the car body can be thrown out of mesh when the car is being drawn over the road. Friction clutches control all opera-

tions, with the exception of applying the propelling power to the truck, which is controlled by a jaw clutch.

A 40-h. p. Scotch horizontal boiler, designed for 150 lbs. pressure, is furnished. This provides ample steam for pile driving or propelling the machine on a level track at a speed of from seven to eight miles per hour. This machine is said to have made a record run as high as 15 miles per hour, but this was under very favorable conditions. All exhaust steam is led into the stack to create forced draft, although a live steam jet is also provided. A three-way throttle valve is placed in the exhaust valve.

The operating mechanism is mounted between massive cast-iron side frames, which are securely anchored to the turntable. The mechanism

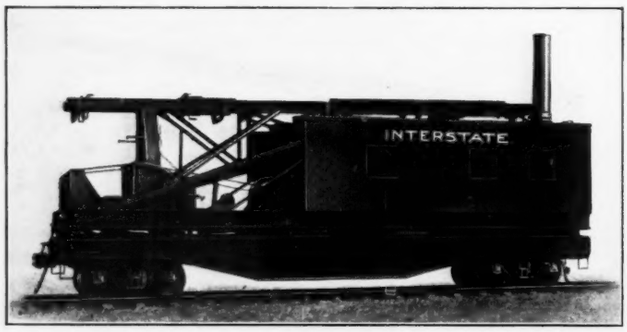


Fig. 1—Interstate Railway Pile Driver.

consists of two drums, one for operating the hammer line and the other for the pile line, and drums for raising and lowering the leads, all of which are controlled by friction clutches. The hammer and pile line drums are mounted on the same shaft, but are independent of each other. Each drum is equipped with a differential band brake operated by a foot lever and the drums for handling the pile and hammer lines are equipped with toothed segments for stopping the drum. The operating levers are mounted in quadrants on a platform located at one side and in front of the machine, affording the operator the best possible view of the work. A hand lever controls the hammer and pile lines, the sluing, propelling, and the raising and lowering of the leads. One lever controls, through a right and left-hand friction clutch, the raising

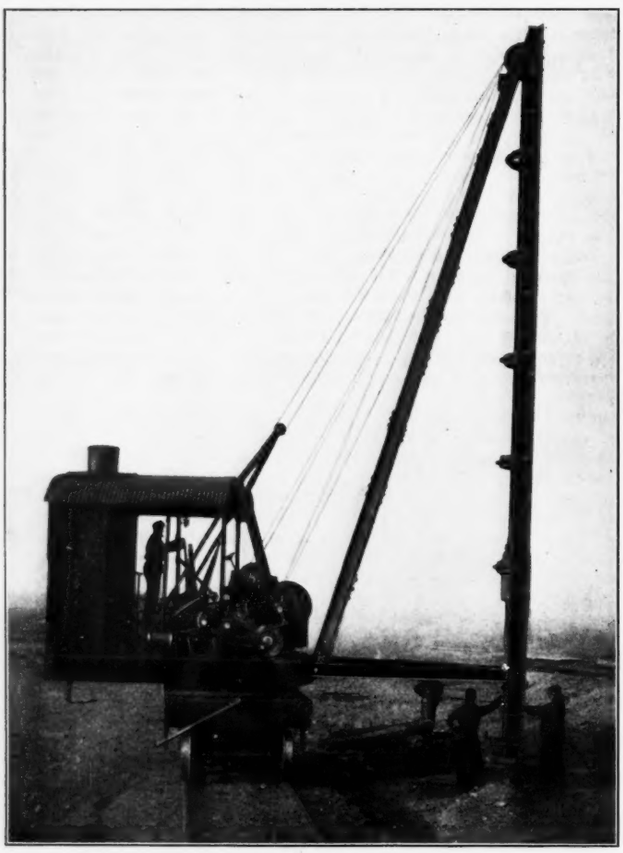


Fig. 2—Driving at Extreme Side Position.

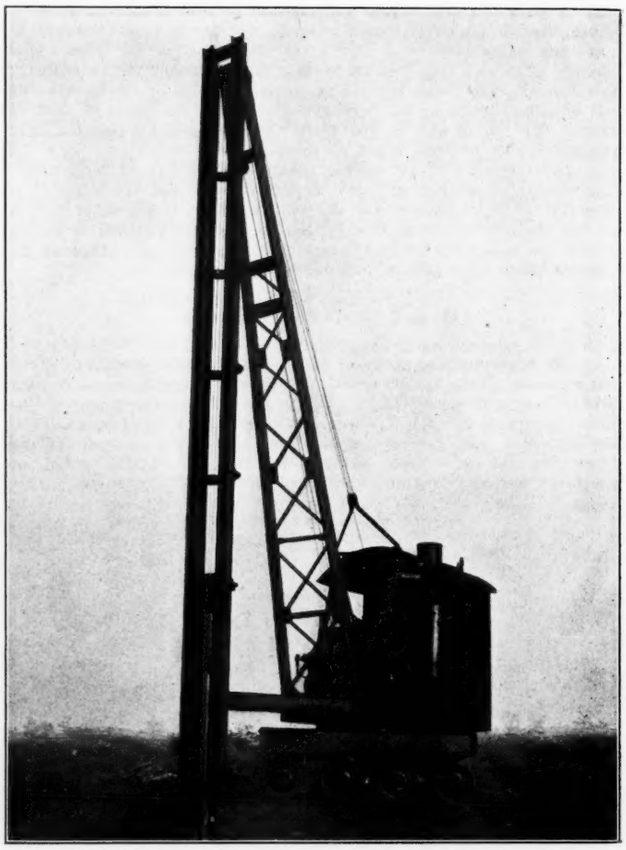


Fig. 3—Driving Pile at Angle With Track.

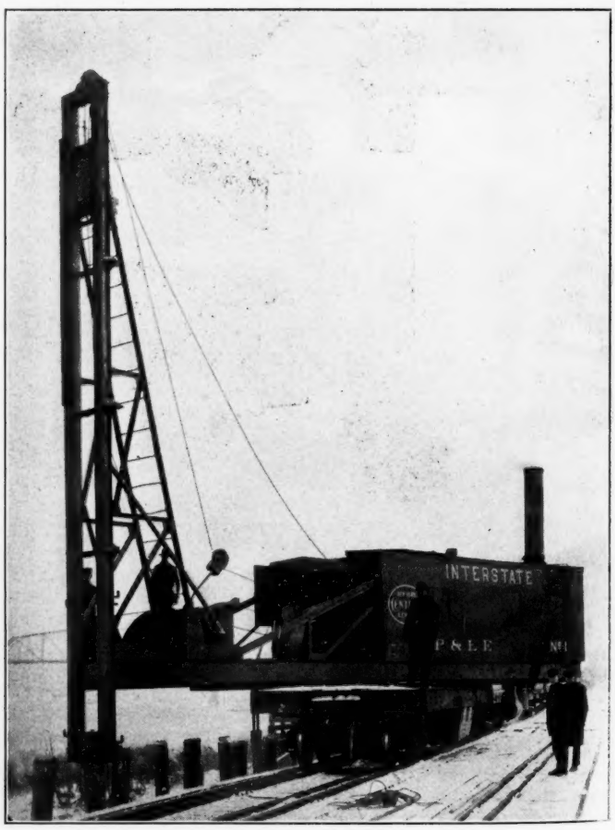


Fig. 4—Interstate Pile Driver on the P. & L. E.

and lowering of the leads. A band brake with a hand lever is provided for the hammer and pile line drums, and the sluing mechanism.

Double horizontal engines, mounted in the operator's cab with the cylinder end toward the rear, are used. This brings the vibration due to reciprocating motion close to the support, which arrangement permits a longer connecting rod than is commonly used and is said to increase the efficiency and reduce vibration of the mechanism.

The car body is provided with Graham-Mitchell draft rigging with either Climax or Tower couplers. The trucks are of the standard pattern with extra heavy arch and inverted bars, designed according to M. C. B. requirements for a 50-ton car. The wheels are chilled cast iron, 33-in. in diameter. Jacks are provided in the bolsters for relieving the truck springs when the driver is in operation. Westinghouse air-brake equipment, including an 8-in. x 7½-in. x 9-in. air pump, is provided, which permits the machine to operate as one car in a train or independently as a locomotive.

These machines are made in two types, Nos. 6 and 7. No. 6 is intended for driving straight piles with a 3,000-lb. hammer, and No. 7 for driving batter piles. The leaders on the No. 7 type are intended to swing to either side, it being possible to place them at any desired angle up to 3 ft. horizontal swing and 1 ft. vertical. In this case the leaders are pivoted at the middle point to a rigid frame mounted on the front end of the turntable, a turned steel pin passing through the upper end of this frame and the steel casting which is attached to the leaders.

For light pile driving work locomotive cranes are also fitted with pile driver attachments as shown in Figs. 2 and 3. The design permits the leaders being taken down and the crane used for hoisting, handling a bucket, etc. These pile drivers are made by the Interstate Engineering Co., Bedford, Ohio, builders of railway locomotive cranes, wrecking trains and steel locomotive pile drivers.

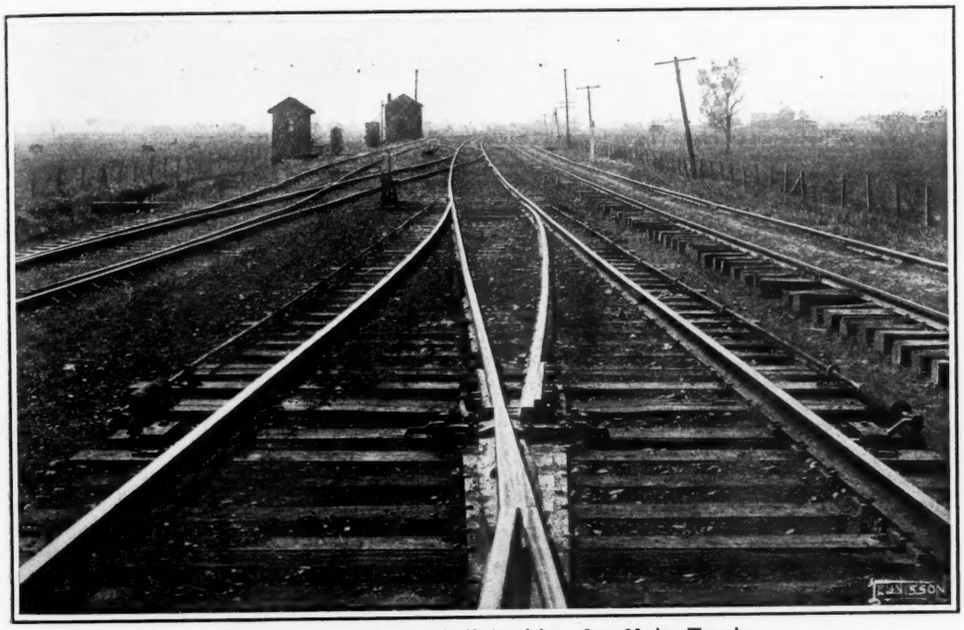


Fig. 1—Continuous Rail in Line for Main Track.

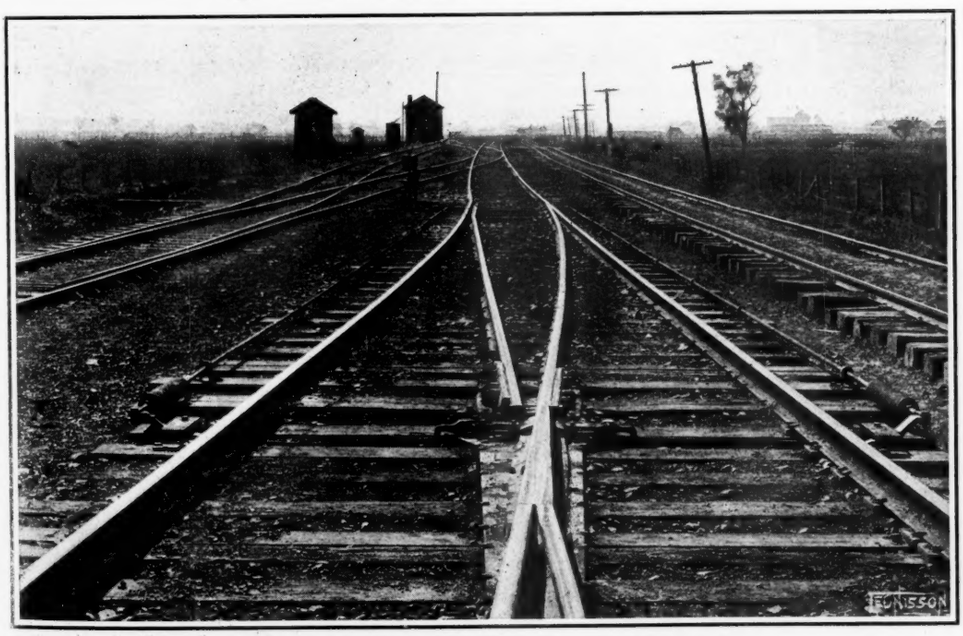


Fig. 2—Continuous Rail in Line for Turn-out.

Continuous Rail Device.

The present rigid frog is much the same as a broken rail; a guard rail is necessary to keep the train on the track as it passes the frog point. In addition to causing derailments, the frogs and guard rails also have a tendency to break the wheel flanges.

The continuous rail device is exhibited at the exhibition of the Road and Track Supply Association at the Coliseum. It needs no guard rail, makes a continuous rail and smooth track both for the main line and turn-out, eliminating pounding and danger of derailment. In these ways, it is claimed, it lessens wear and tear on rolling stock and reduces operating expenses.

There is a large base plate of cast steel, about 9 ft. long, to which is attached at each end to lugs, which are part of the base plate, the four connecting rails. The movable rail is of cast steel, hardened. The limit stops are protected by the base of the movable rail, so as to prevent any foreign matter from interfering with operation. These three limit stops, one at each end and one in the center of the movable rail, are cast integrally with the base plate and fit in corresponding sockets in the movable rail. When the device is set for the main line, the movable rail is bearing against these limit stops on one side, and when set for turn-out it bears against the opposite sides of the limit stops.

The device as shown in Figs. 1 and 2 is for main line use, being connected with the switch point by connecting rods as shown. The accompanying will provide, however, for situations in yards where speeds are low, a connection by which an engine or car coming out of the side track with the device in the position shown in Fig. 1 will, before reaching the device, set it for the side track.

One of these devices was placed at a point on the Mobile & Ohio Railway, where it had been necessary to replace the frog and guard rail on an average of every three months. This continuous rail device has now been at this same point for over seven months without showing wear at any point. The device, it is claimed, will last the life of the abutting rails. The devices are now being used by the Mobile & Ohio at East St. Louis, Ill.; the Southern Railway (St. Louis-Louisville Division) at East St. Louis, Ill.; the St. Louis & San Francisco at St. Louis, Mo.; the Chicago, Rock Island & Pacific at Chicago; the Southern Pacific (Morgan's Louisiana & Texas) at New Orleans, La.; the Missouri, Kansas & Texas at Parsons, Kan.; the Litchfield & Madison at Edwardsville, Ill.; and the St. Louis-Southwestern at Pine Bluff, Ark. They can be seen in actual operation at all these points. The device is made and sold by the Continuous Rail & Safety Switch Co., whose sales office is in the Syndicate Trust Building, St. Louis, Mo.

Cincinnati High Power Milling Machines.

The development of an all gear spindle drive milling machine by the Cincinnati Milling Machine Company, Cincinnati, Ohio, has resulted in a new line of high power machines, and some of the more notable of them are here described and illustrated. These machines were designed for taking heavy cuts on work where fast feeds are permissible and especial attention has been given to those details which provide for the convenience of the operator.

The starting point in the design is the amount of metal removed, as the modern basis for selling such machines should be the quantity and quality of work produced and not the weight of the machine and the size of the driving pulley. The standard cut has a rate of feed sufficient to remove 8 cu. in. of machinery steel, 55,000 lbs. tensile strength, per minute in continuous service and the maximum cut is much larger.

Each machine consists of a system of units composed of the several groups of mechanisms, such as, the drive box, the feed box and the reverse box. Each of these units is made interchangeable on all machines, horizontal and vertical, of each size. This permits of changing a machine to a right angle drive or motor drive at any time by substituting the desired drive box for the one in use. The general appearance of the exterior of these drive and feed boxes is well illustrated in Fig. 5. The drive is through a constant speed belt and no counter-shaft is required. The main driving pulley is of large diameter, wide face, and running at a high speed delivers more than twice as much power to the spindle as is possible on the cone driven machine of former design. This pulley is not fastened directly to the driving shaft, but is journalized on a bracket bolted to the column of the machine and the entire pull of the belt is taken by this bracket. A disk friction clutch of large proportions connects the pulley to the

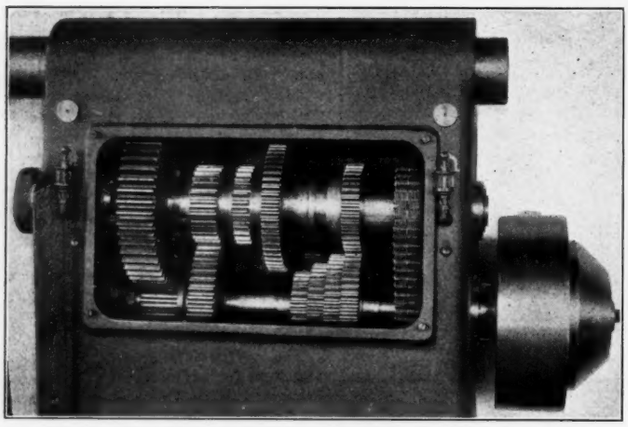


Fig. 1—View Showing Driving Gears; Cincinnati Milling Machine.

driving shaft and the machine is started and stopped by operating this clutch by the lever located at the front of the machine. When the clutch is out, every part of the machine stops except the main driving pulley, and when the clutch is thrown in, the power is transmitted to the main driving shaft and the driving gears shown in the details of the driving gear boxes. All changes of speed are made through the pilot wheel and the two handles shown next to it, and the index plate, seen in Fig. 5, shows the lever combinations for any desired speed.

Fig. 1 is a detail of the upper part of the column with the cover plate removed, showing the driving gear train.

Fig. 2 is an interior view showing the driving gear box cover and the connections for the handles outside. The machine having been stopped to change the speed, the gears may interfere with the shifting levers and it is therefore necessary to revolve them slightly. This is accomplished by the treadle shown in Fig. 3. It is connected to the main clutch lever and operates on an auxiliary disk clutch. The operation of speed changing, therefore, consists in selecting the lever position for the desired speed, setting the pulley wheel to its position, moving the change lever as far as it will go and then if the gears interfere exerting a light pressure on the treadle. This does not require the operator to turn the gears over by pulling on the belt or on a hand wheel or other device with one hand, while attempting to shift the levers with the other hand as he operates the treadle with his foot.

Fig. 4 shows the motor drive arrangement. The motor is mounted on an extension of the base at the rear of the machine where it is entirely out of the way and does not increase the floor space, since the space it occupies is not available for other purposes, as it must be kept open to accommodate the table travel. The drive is through

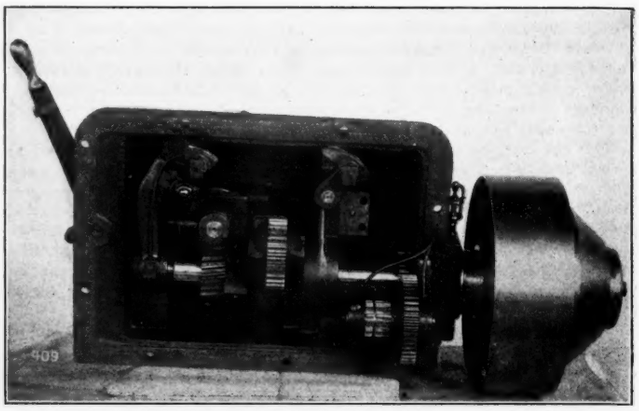


Fig. 2—Interior of Gear Box.

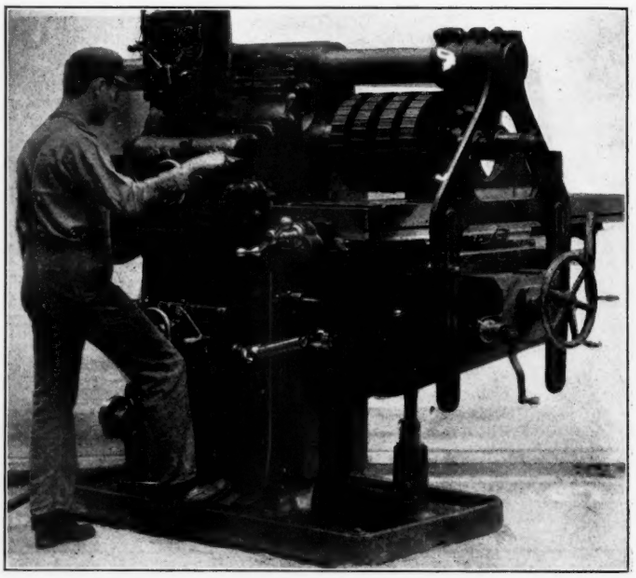


Fig. 3—View Showing Position of Operator and Convenience of Adjustments.

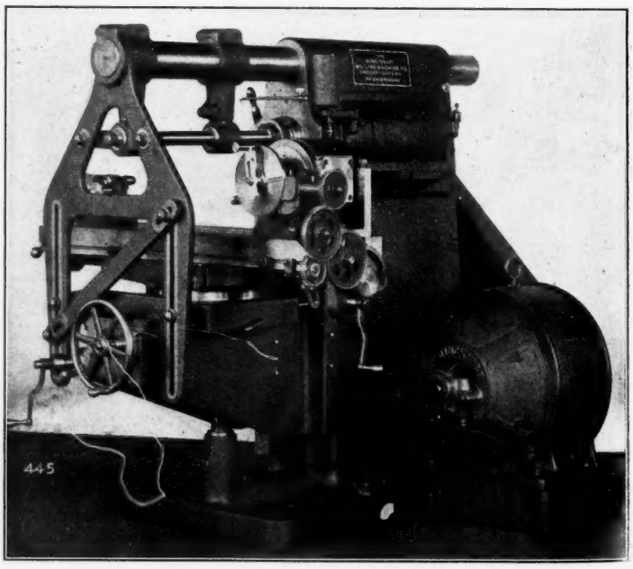


Fig. 4—View Showing Motor Attachment and Outer Arbor Bearing Support.

reducing gears direct to the driving shaft by means of a silent chain. Either constant speed or variable speed motors can be used, but for variable speed standard motors are used with two to one speed variation.

The column of these milling machines is a box section of liberal dimensions, provided with stout walls for supporting the knee and

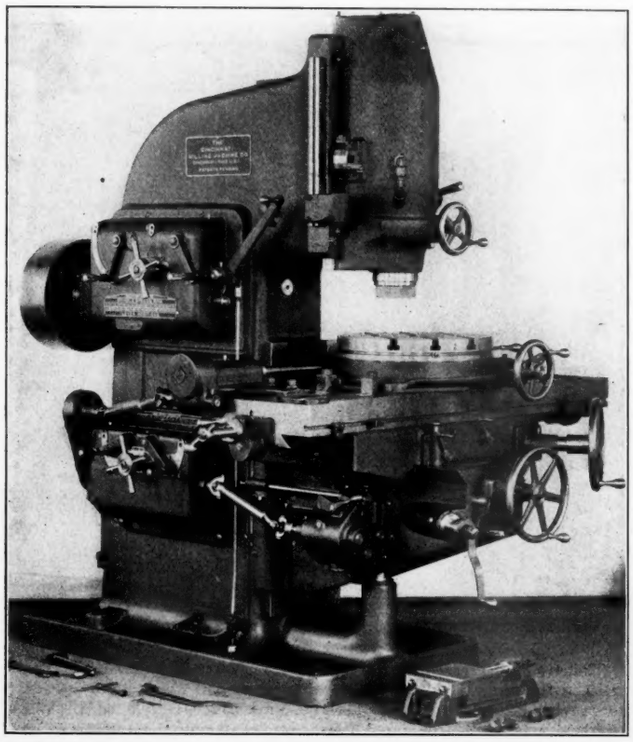


Fig. 5—Cincinnati Vertical Spindle Milling Machine Showing Location of Gear Boxes.

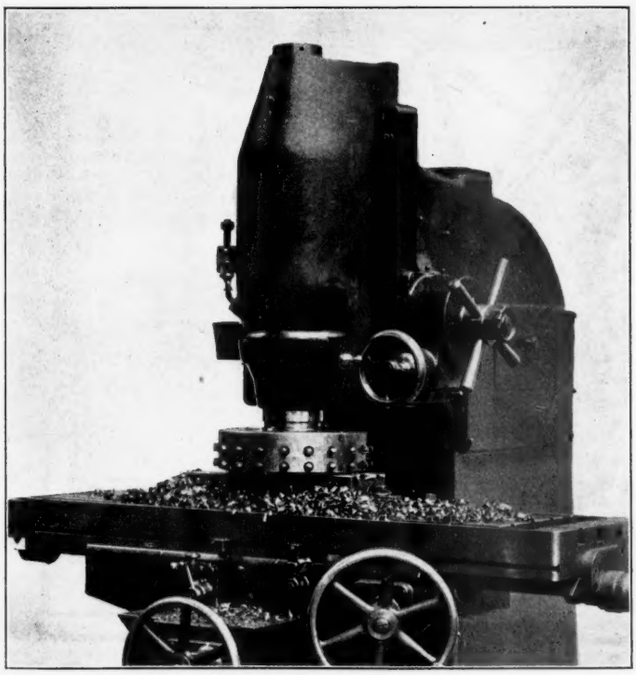


Fig. 6—Vertical Milling Machine Removing 10 cu. in. of Steel Per Minute.

both the front and rear spindle bearing. The knee is of box section exceedingly heavy and rigid for each size of machine. The table has unusually great vertical depth giving it stiffness as a beam to resist springing when work is clamped to it. Fig. 4 shows the outer arbor bearing support. When doing heavy milling it is important that the outer arbor bearing be rigidly supported and to accomplish this the machines are fitted with a solid overhanging arm of large diameter and massive braces of truss form made in one piece. To further increase its stiffness when milling is done with the knee in its lowest position an additional diagonal brace is provided.

Fig. 5 shows the circular milling attachment which is entirely of new design. It is made to fit interchangeably any of the standard high power vertical and horizontal millers made by this company and it of ample proportion to do milling up to the full capacity of the machine. This is geared direct to feed mechanism and has 16 changes in the feed. Its drive is by a shaft independent of the regular feed shaft, and therefore the power feed of the machine can be used while the circular milling attachment is in place. It is adapted for either internal or external milling. This attachment is made in sizes 16, 20, and 24 in. in diameter.

Fig. 6 shows a portion of the high power vertical miller at work milling forged steel bars having 55,000 lbs. tensile strength. The bars are 5 in. wide and the machine takes a cut ⅛-in. deep feeding 16 in. per minute. This amounts to 10 cu. in. of steel removed per minute, the motor using 12 h.p. This machine was on exhibition at Atlantic City last June, but at that time it was taking a cut ¼-in. deep with a feed of 8 in. per minute on the same quality of steel. This also was equivalent to the removal of 10 cu. in. of metal per minute.

Fig. 7 illustrates a portion of the No. 4 plain horizontal milling machine which was also exhibited at Atlantic City last year, although

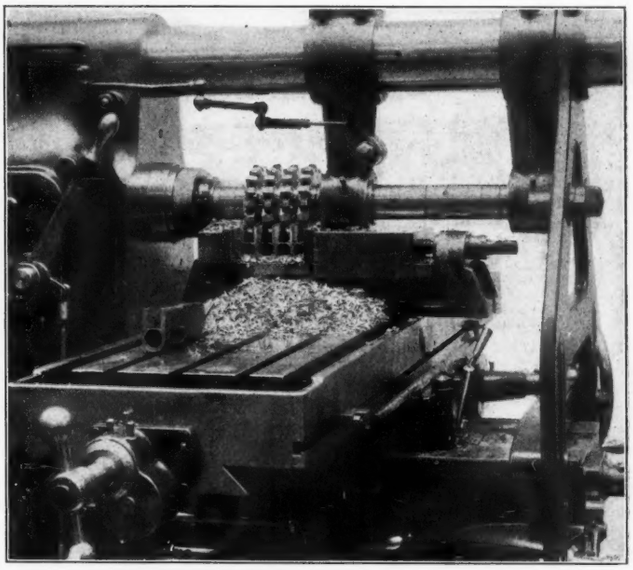


Fig. 7—No. 4 Horizontal Cincinnati Milling Machine.

it was not then doing heavy milling. The cut shows it milling four drop forged steel pieces at one time, taking a cut in each piece $\frac{13}{16}$ in. wide and 1¼ in. deep with a table travel of 2 in. per minute. This amounts to 8⅛ cu. in of steel removed per minute with a consumption of 10 h.p. This is remarkably heavy cutting when using cutters on a horizontal arbor, and it is evidence of the very high efficiency of the machine.

Roll Bascule Bridges at Indiana Harbor.

To provide a water outlet for the industries at Indiana Harbor, Ind., the Indiana Harbor Land Co. decided, early in 1907, to build a ship canal connecting Lake Michigan with various manufacturing plants already located at that point, and for new industries that might be attracted there by its favorable situation as a manufacturing center. As a preliminary to the building of the canal, the land company induced the various railways that would cross it to build movable bridges, so that when the canal should be opened, navigation and railway traffic would not be hampered by interference from construction work. The three roads concerned, the Pennsylvania Lines, the Lake Shore & Michigan Southern and the Baltimore & Ohio decided to invite tenders jointly, after adopting the bascule bridge as the type that would meet all the requirements, and especially the requirement that additional tracks and the bridges to carry them might be installed without changing the existing tracks and bridges.

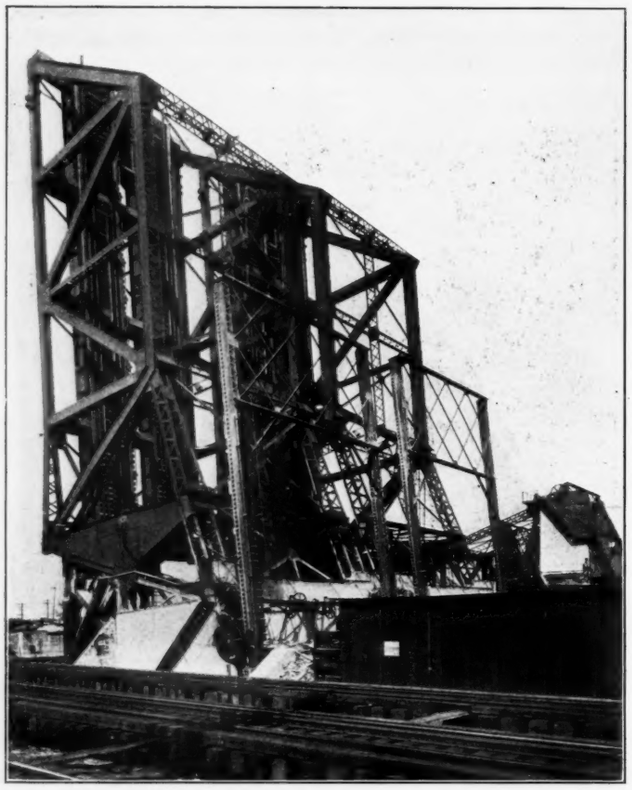
The Rall bascule bridge was chosen by the three roads and a contract given to the builders for four double-track bridges, duplicates of each other, two of which were for the Lake Shore and one each for the other roads.

The substructures were designed by the railway companies, being

concrete piers on wooden piles. As there was no navigation, each railway built a pile and timber runaround, so that traffic would not interfere with the work. Coffer-dams were built and pumped out to the elevation of the bottoms of the piers. The piles were driven with a water jet. As the material to be penetrated was water-bearing sand, some difficulty was experienced on account of the washing away and undercutting of the sand.

Each bridge consists of a double-track, through riveted single-arm span of the Ball type, the river arm being 86 ft. long, center to center bearings. The principle of the design is shown by the accompanying drawing. The bridge does not require a pit for receiving the tail arm in the opened position. In the closed position the bridge rests directly on the forward pin bearings at the counterweight end of the river arm and on cast steel shoes at the other end. These bearings take the entire live load and part of the dead load in the closed position. The proportioning of the parts was in strict accordance with the requirements of the specifications of the Pennsylvania Lines West of Pittsburgh.

The tail, or that part of the bridge from which the counterweight is suspended, is 28 ft. long and consists of an irregular polygon, the forward portion of which is a triangular girder in which the trunnion or turning pivot of the truss is mounted, the center of this pivot being



Open Position; Roll Bridges on Lake Shore.

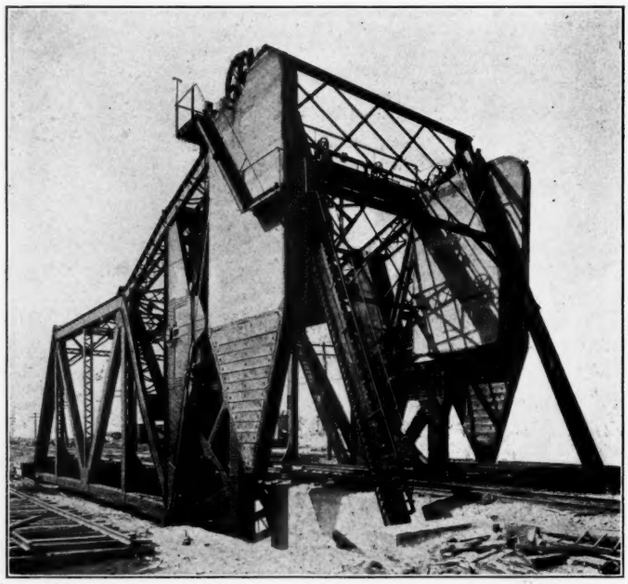
the center of gravity and the center of rotation of the movable part of the bridge. The motion is controlled by the swing strut, which is connected with the forward fixed pin support and free to move around it, and pin-connected with the triangular girder part of the truss at a point somewhat back of and below the trunnion.

The bridge is operated by means of a pinion mounted on the bridge and meshing into a straight rack in the operating strut. The latter is located at the extreme end of the bridge, back of the counterweight. This operating strut is hinged at the bottom to the foundation and is free to accommodate itself automatically to the irregular curve described by he pinion in the tail of the bridge while in motion. This method of applying the power is one of the special features of this design. There are no racks or tracks for the bridge operation, greatly simplifying the work in the office, shop and field. The operating gear is held in mesh by means of a steel carriage which travels along a track at the rear of the operating strut and is connected with the axle of the main pinion and moves with it.

The trunnion about which the bridge rotates is carried by a roller or wheel which turns around the trunnion. This roller has a cast iron center on which are shrunk steel tires 1½ in. thick.

The journal bearings between trunnions and rollers are bronze bushed, the maximum pressure being 1,600 lbs. per square in. The trunnions are 14 in. in diameter and 4 ft. long. The rollers are 55 in. in diameter and have a smooth face of 25 in. with a flange at the outer edge for alinement of the bridge. The pressure is 22,000 lbs. per lineal inch.

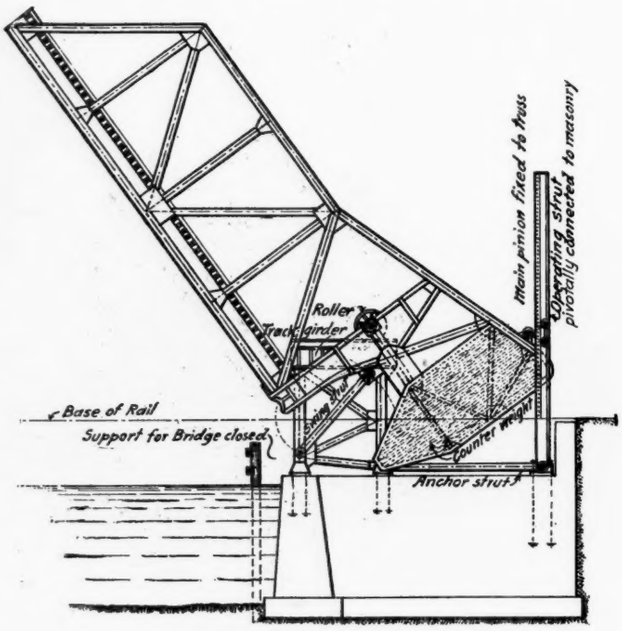
The track on which the roller travels is straight and short, the travel opening the bridge being made just long enough to enable the tail to clear the masonry when the bridge is open. The retractile motion of the bridge permits of the use of a minimum length of span, which reduces the cost.



Closed Position; Roll Bridge on Baltimore & Ohio.

The track girder carrying the bridge while in motion has three webs with side plates and deep channels in the top chords in order to provide proper rivet areas for the large concentrated loads. When the bridge is closed the roller bears but lightly on the track and consequently the live and dead loads are not carried by the trunnion and track girders, but by the forward pin supports and the bearings at the extreme end of the bridge.

The counterweight consists of cast iron blocks for its lower third,



Design of Roll Bridge.

carried by and bolted to a steel framework, continuous with and an integral part of the main trusses. The upper part of the counterweight consists of stone concrete in which pig iron is embdedded. The concrete is also reinforced with heavy wire meshing and tied transversely by iron rods. The concentration of load possible with cast iron blocks for a part of the counterweight made their use more

economical than to have the entire counterweight of concrete. Provision is made for attaching additional cast iron counterweight blocks if necessary.

Each bridge is equipped with the necessary bridge and rail locks and river signals. The operating machinery consists of three sets of cast steel gear wheels connecting with each motor and meshing into the straight rack of the operating strut. A reinforced concrete platform connects one truss with the other at the op of the bridge for convenience of the bridge tender in oiling and caring for the machinery. The main trunnions are lubricated from this platform through gaspipe conduits and pressure grease cups.

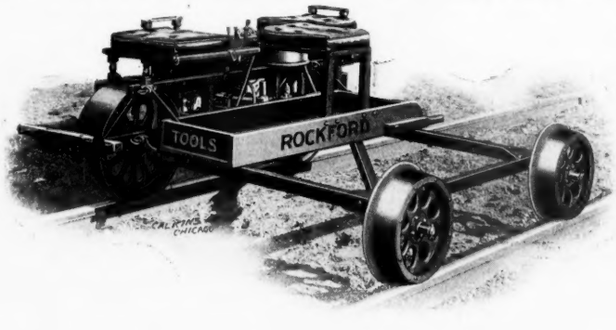
Each bridge is moved by two 35 h.p., 220-volt, d. c. motors, geared to the main cross-shaft. The actual power required to open or close the bridge in one minute under ordinary wind conditions is 25 h.p. Therefore one motor is sufficient to operate the bridge safely, the second being for emergency purposes. Each motor is equipped with an electric solenoid brake, normally set by means of a spring and released by the controller. A hydraulic emergency brake on the driving shaft is operated by a hand-pump in the operator's house. The rail locks are operated at 2½ h.p. d. c. motor, and the end lock by a similar motor.

The Pennsylvania's bridge, being remote from the others, is operated from the signal tower adjacent to the bridge. The other three bridges are operated from the signal tower controlling the tracks of the roads using the bridges, the power plant being in the same building. This installation is of interest because of the number of drawbridges operated from one point. Three-phase alternating current, at 440 volts, from a power company, is transformed to direct current by two 40-amp. mercury-arc rectifiers. It charges a storage battery of 128 "Chloride Accumulator" cells, used for operating the several bridges, and for the electric interlocking and signal system governing the tracks crossing the bridges. In addition there is a direct-connected 35 k.w. motor-generator set, for emergency or joint use with the battery. The several motors on each bridge are electrically interlocked with each other and with the signals governing the approaching tracks. Nothing can be done toward opening any bridge until all signals governing the approaching tracks are set at "danger," and in closing, the signals cannot be set for a clear track until the bridge is closed and locked and the rail locks set for the passage of trains. Each bridge has its own switchboard and controllers, and each board has electric indicators showing the operator the position of all devices on the corresponding bridge.

The weight of structural steel for each bridge is 626,000 lbs. and of the entire operating machinery 27,000 lbs. The Strobel Steel Construction Co., Chicago, who designed the bridges, prepared all plans, erected the superstructure and installed the machinery. The structural steel was fabricated by the Pennsylvania Steel Co., Steelton, Pa., and the machinery was furnished by George P. Nichols & Bro., Chicago, who also furnished and installed the electric equipment. The railway companies were represented by Albert Lucius, Consulting Engineer, and by their respective bridge engineers.

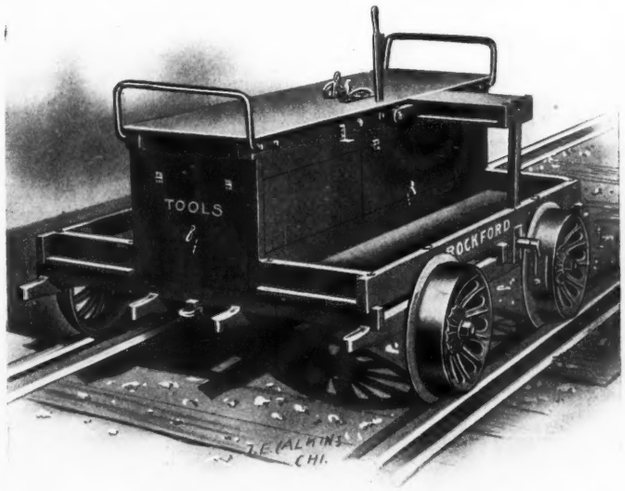
Rockford Motor Cars.

The Rockford gasolene motor cars for section men and signal, telegraph and bridge inspectors, manufactured by the Duntley Manufacturing Company, 1913 Fisher building, Chicago, have been in successful use about three years, and are now being ordered in large numbers. Fifty-four of the No. 4 motor cars have been delivered to the Chicago.



Rockford Inspection Car No. 2.

Milwaukee & St. Paul. The simplicity of the cars is readily seen in the illustrations. They have no gears, no friction clutch, no chains and no water cooling apparatus to freeze up in winter. Some doubts have been expressed as to whether this gasolene engine would run successfully without some sort of a cooling device, and tests have been made to determine its running conditions. The engine was operated at a speed of 360 revolutions per minute at a temperature of 115 deg. for one hour continuously. This corresponds to a speed of 26 miles per hour. In the test, the engine was enclosed so that it did not have the benefit of the cooling effect of the air rushing past at 26 miles per hour. This proved conclusively that the engine could be operated in hot weather without a water cooler. The advantage of the high speed car is in getting men to and from their work, resulting in a saving of one to two hours per day for each man. The car is also useful in making a quick delivery of material in urgent cases, and the section foreman can get over his section more frequently and detect track defects. The saving of time of extra and section gangs and of labor in operating ordinary hand cars has been estimated as equal to $50

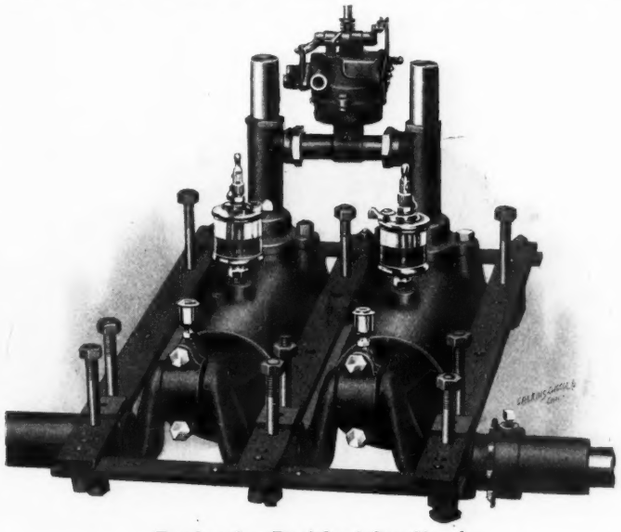


Rockford Section Car No. 4.

per mile per year. The engine can easily be applied to any standard hand car if desired.

The No. 4 Rockford section car is intended to take the place of the hand-driven cars in common use. The axles are steel, 1⅝ in. in diameter; wheels 16 in., platform 6 ft. x 52 in. The car can be worked up to a speed of 30 miles per hour. It will carry 10 men, including the operator, and has sufficient power to carry as many men and tools as can be crowded on the platform. The car has been tested under a load of 5,100 lbs. at a speed of 6 miles per hour on a 1½ per cent. grade. Its weight is 650 lbs.

The inspection car, No. 2, which is also shown herewith, is specially adapted to signal telegraph and bridge inspection; it accommodates



Engine for Rockford Car No. 4.

two passengers in addition to the operator and has a tray for carrying tools. The engine is capable of operating 90 miles on one gallon of gasolene when the speed does not exceed 20 miles per hour. The weight of the car complete is 350 lbs. and it can be easily removed from the track by one man in 3 seconds.

For extra heavy service the No. 5 car is recommended. This has four cylinders directly connected to the axles and when maximum power is not required either pair of cylinders can be cut out or in at any speed. In transferring material two loaded hand cars can be handled by the No. 5 car, and it is fitted with a drawbar for this purpose.

Foster Interlocking Switch Stand.

The Foster interlocking switch stand is designed for main line facing point switches not connected with an interlocking plant. It is arranged to operate a distant signal suitably connected so that the signal can

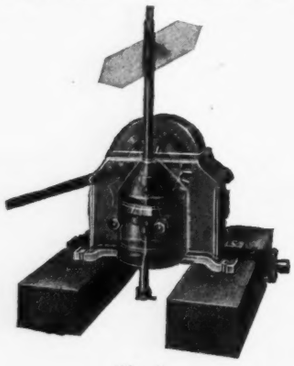


Fig. 1.

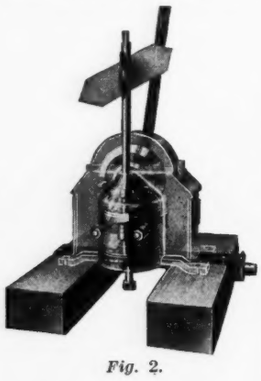


Fig. 2.

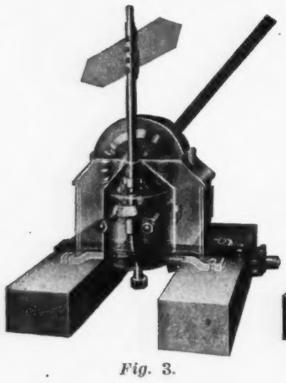


Fig. 3.

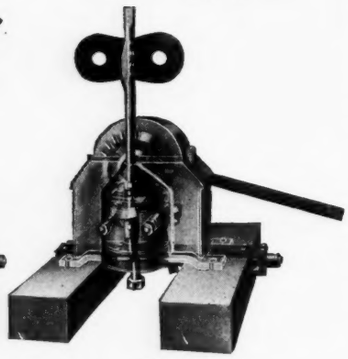


Fig. 4.

Foster Interlocking Switch Stand.

be pulled clear only when the points are set for the main line. All the operations are made by one lever.

The lever, in one motion parallel to the track, performs successively three operations; throwing the switching points, locking them in position and clearing both the target and the distant signal. Revere motion of the lever throws both signals to danger, unlocks the points, then opens the switch. When it is desirable to do switching and have the protection of the distant signal, the switch points can be thrown by moving the lever back and forth between the position shown in Figs. 1 and 2, and the signals be allowed to remain at "stop."

The switch stand and the locking parts are spiked to the ties independently and when the points are set for the main line, the switch stand could be removed or destroyed without imperilling the safety of the switch. The interlocking connection may be placed below the top of the tie if desired so that in case anything drops from a car it will be protected.

Fig. 1 shows the lever in the position it takes when the switch is opened. The first operation is accomplished by moving the lever to the position shown in Fig. 2, when the switch points are set for the main line. At this point the gear operating the switch point locks and remains locked until the throw of the lever is completed. When the lever is in the position shown in Fig. 3, the switch points are locked in place by a plunger which passes through the locked bar. When the lever moves to the position shown in Fig. 4, the target is in the clear position. Moving the lever from the third to the fourth position, operates two gears simultaneously, one gear turning the target 90 deg., and the other turning the sheave 160 deg. This sheave is grooved for a chain which works the distant signal.

If the point should not come up close to the stock rail in closing the switch, the plunger will not enter the hole in the lock bar, and the lever will not take the position shown in Fig. 2 and as the gears operating the signal do not engage until the lever reaches the third position, the signals cannot be cleared unless the points are interlocked. Each of the intermittent gears is locked when not in motion, and can only be operated by moving the lever through the portion of its travel for that particular gear. As the gear turns 180 degs., the crank is on the dead center when the points are set for either track. The lever can be locked only when it is in one of the extreme positions. This switch stand is patented by Frank M. Foster, Columbus, Ohio, and is now in service on the Toledo & Ohio Central, at Columbus, Ohio.

Duff-Bethlehem Forced Steel Hydraulic Jacks.

The Duff Manufacturing Co., Pittsburgh, Pa., exclusive manufacturer of the Barrett jacks and the Duff ball-bearing screw jacks, has put on the market the Duff-Bethlehem forged steel hydraulic jack. This jack is forged entirely out of steel and patents covering its special features and construction have been allowed the Bethlehem Steel Co., South Bethlehem, Pa., which has designed and perfected this jack and which does the special forgings necessary. The Duff Manufacturing Co. has the entire and exclusive handling of this Duff-Bethlehem jack.

The new jack has special features whereby all imperfections and troublesome conditions in a hydraulic jack are avoided. It weighs from 30 per cent. to 60 per cent less than a hydraulic jack of any other make of equal lifting capacity and stroke. This is made possible by its forged steel construction. It further provides greater strength, capacity and durability.

Both the cylinder and ram have a solid bottom, thus requiring no packing and dispensing with joints at those points. The most troublesome packing in a hydraulic jack is at the bottom of the cylinder. As the cylinder of the Duff-Bethlehem jack has its base, or bottom, forged integrally therewith, it obviates entirely this trouble. Another packing that frequently causes trouble and expense is the one insuring closure of the ram piston from the pump socket. The new jack has a solid ram bottom forged integrally with the pump socket, thus dispensing with this packing. There are only two packings proper in the jack, and these are small. As joints are also eliminated, there is no chance for leakage and no expense watever for renewal of packings.

By the improved construction and location of valves, the jack can be extended its full length in a vertical, horizontal or inclined position, without an adjustment whatever, and all sizes will separate at any angle. In the operating mechanism, a minimum number of parts of simple and strong construction are employed and any parts may be easily replaced if necessary, without special tools. Also, the valves may be attended to without removing the packing, and the packing without removing the valves. The valves are positive and require no special adjustment or parts to insure their operating under all conditions. The load may be tripped or may be lowered as slowly as desired, or stopped at any point when lowering.

These jacks are constructed of open-hearth fluid compressed forged steel and bronze, and their inside working parts are drop forgings. They are made in all types and capacities adapted to railway and general lifting purposes. The low or telescopic type, representing the highest development, is fitted with an improved duplex pump, automatically regulating the change of speed proportional to the load being lifted.

Duff-Bethlehem Hydraulic Jacks.

It is made regularly with capacities ranging from 30 tons to 300 tons, and higher capacities if required.

This line of hydraulic jacks is complete, and together with the Barret jacks, Duff ball-bearing screw jacks, etc., covers needs for lifting jacks for all purposes from jacks lifting 500 lbs. up to those capable of lifting 1,000 tons.

Scherzer Rolling Lift Bridge in Burma.

In August, 1904, the Burma Railways Company began work on an extension from Henzada to Kyangin. This work necessitated the construction of a bridge to cross the Ngawun river, about 16 miles from Henzada. It was originally intended to build this bridge of fixed spans, grading up the approaches so as to provide a clearance of 40 ft. underneath the bridge for the passage of vessels, but as this construction would require a grade of ½ of 1 per cent., it was decided to reduce the grade to ⅛ of 1 per cent., and include a movable bridge for the channel span.

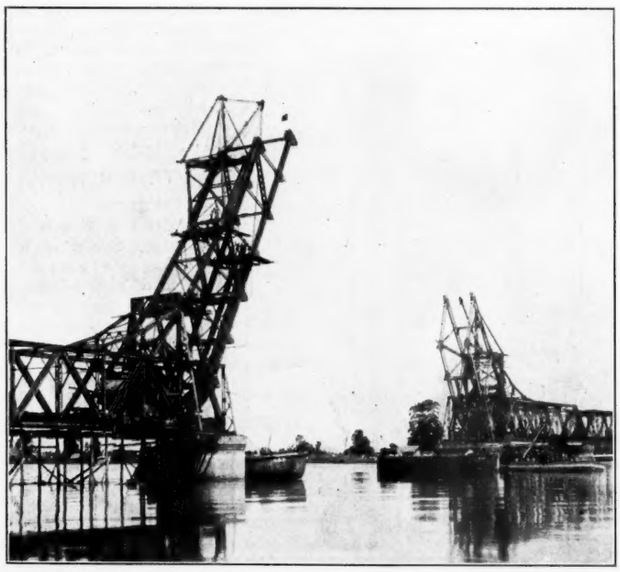
Scherzer Rolling Lift Bridge Across Ngawun River, Burma.

Extensive navigation is carried on along the Ngawun river by the Irrawaddy Flotilla Company, which operates a line of steamers for both freight and passenger traffic. The Government required a clear channel of 200 ft., for navigation, which, with the local conditions, caused careful consideration of the most suitable type of movable bridge. A double-leaf, through Scherzer rolling lift bridge was selected.

The bridge was fabricated at the works of Spencer & Company, Melksham, Wiltshire, England, and was shipped to Burma after having first been erected temporarily at the works.

The superstructure consists of a double-leaf, through single-track rolling lift bridge having a span of 220 ft. center to center of bearings, flanked on one side by three 160-ft. through truss spans, and on the other by two spans of this same length. The substructure consist of brick masonry piers founded on wells, the type of construction generally used in India and Burma. The design of the bridge was based on the specifications of the Government of India for railway bridges.

The superstructure of the fixed spans was erected on falsework composed of frame bents resting on piles, there being four towers of two bents each for each approach span. The leaves of the bascule span were erected in the open position by means of a sliding derrick which was raised on the open leaf as each panel was added. In this way the channel was not obstructed during erection. As shown in one of the photographs, work was carried on on both leaves at once. Another photograph shows the method of placing the end floor beam after the leaf has been operated to closed position.

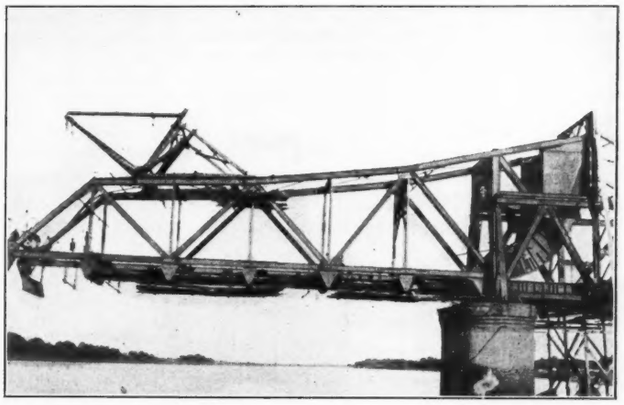


Erection of North and South Leaves.

The track girders on which the moving leaves roll in opening and closing, are carried by the adjacent fixed spans, eliminating the piers usually provided to support the rear ends of the track girders. One of the distinguishing characteristics of the design of this bridge is the economical arrangement and the small size of the piers, providing ample support to the superstructure with the least possible obstruction to the flow of water. The rivers in India and Burma during the rainy season are subjected to heavy floods and obstructions to the flow of water result in deep holes being scoured in the rived bed, necessitating great care in foundation design. The great advantage of the bascule bridge over the swing bridge in this respect is apparent from a study of the general view of this bridge. In this photograph, showing the movable span closed, the water of the river is at a low stage.

The bridge is operated by hand power from winches on the deck of the approaches, transmitted by a system of gearing to the main operating struts, of which there are two on each leaf outside of the trusses, the center line of the struts coinciding with the center line of the approach trusses. The two winches for operating each leaf are located on platforms on the outside of the approach spans.

The substructure was completed and erection started in the spring of



South Leaf Operated to Closed Position.

End View from South Abutment.

1908, the bridge being completed and opened early in December, 1908.

This is the largest movable bridge yet built in Asia, and its successful and satisfactory completion will undoubtedly lead to the construction of other bridges of this type where similar problems are to be solved. By the use of the rolling lift bridge the base of rail can be placed at a minimum distance above water, effecting a large saving as compared with the cost of a fixed bridge high enough above the water to allow vessels to pass underneath, necessitating the construction of long and high embankments to reach the bridge level. The grades would be a perpetual tax on all traffic crossing the bridge.

The work was executed under the supervision of Rendel & Robertson, Consulting Engineers, 8 Great George street, Westminster, S.W. The Scherzer Rolling Lift Bridge Co., Chicago, designed the superstructure of the bascule span and the two adjacent approach spans in co-operation with the engineers of the railway company. The substructure was designed by the railway company. G. Mills was in direct charge of the work as Chief Engineer of Construction for the railway until the completion of the substructure, being succeeded by J. A. Despeisis, Superintendent of Ways and Works. A. E. Kindersley was Executive Engineer. C. B. Bell was Assistant Engineer in charge during the construction of the substructure, and J. Rowland was Assistant Engineer in charge of the erection of the superstructure. James I. Vincent was Resident Engineer for the Scherzer company during the erection of the superstructure.

Color Perception Testing Lantern.

The accompanying photographs show the latest model of Dr. C. H. Williams' lantern for testing color perception. There are eighteen different glasses in the revolving disc, and they can be shown, either singly, or in pairs for comparison of colors, for instance, two reds of different shades, two greens, a red and a green, etc., in eighteen different combinations, and with a large, medium or small illuminated area, regulated by the sliding shutter inside the lantern. Under each color is a number which is lighted when that color is shown, the number being screened from the person examined, but visible to the examiner. This is done by a circular steel plate which is in front of the numbers, but allows them to be seen from the side. It was removed when the accompanying photograph was taken. These numbers allow a record to be made of the examination, each number with the name of the color given to it, being noted as the examination proceeds. Every glass in each of these lanterns is personally tested by Dr. Williams before the lantern is sent out.

The rear view shows electric lights in use. Oil lamps are also furnished. The lantern is placed 20 ft. from the person to be examined,

Front and Back Views of Williams Lantern.

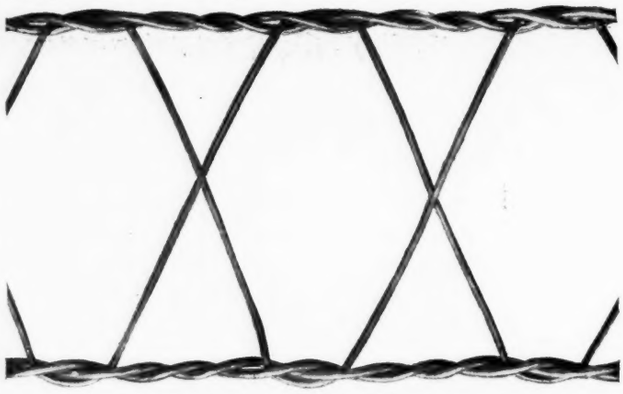
and on a level with his head, the side of the lantern carrying the disk with the colored glasses facing directly toward him. The disk is revolved, showing different pairs of lights and also single lights by manipulating the shutter.

The names given to the colors by the person examined are recorded and checked by reference to the corresponding figures on the small dials. With the smallest opening in the shutter, the apparent size of the colored light at a distance of 20 ft. is the same as the apparent size of a switch light five inches in diameter seen at a distance of 1250 ft.; and with the largest opening in the shutter, as the apparent size of such a switch light at a distance of 160 ft., but it must be remembered that with colored lights the color can be distinguished, at night, at a much greater distance than objects of similar size could be seen by day, and the size of the colored area of a signal light at night does not bear the same relation to the ability to see it that the size of a semaphore, or position signal, would by day.

This lamp is made by Peter Gray & Sons, Boston, Mass.

Wright Rust Proof Wire Fencing.

The accompanying illustration shows a section of rust proof wire fencing which is woven from plain hard drawn steel wire of high tensile strength, after which it is galvanized by being passed through a bath of molten pure zinc, which process is said to result in a heavy protective coat equal to about 20 per cent. of the weight of the fence. The manufacturers claim that the important feature of his fencing lies in the method of its manufacture, in that the coating of pure zinc, equal to about 20 per cent. of its weight, put on after the fencing is woven, is superior to other makes of fencing made of wire which is galvanized to about 3½ per cent., of its weight before being woven



Wright Rust Proof Wire Fencing.

into fencing. It is also claimed that the fencing which is made by the latter process will last from three to four years, and that the rust proof fencing, which has a coating much heavier, will last from six to eight times as long.

It is said that poultry netting, made from No. 20 wire, which is galvanized after weaving, and has a coating equal to about 16 per cent. of its weight, has lasted as long as 24 years. Rust proof fencing is said to be very strong and long lived on account of the heavy coat of zinc, adaptable for many purposes, easy of erection and requiring a comparatively small number of posts. This fencing, manufactured by the Wright Wire Co., Worcester, Mass., is shipped in compact rolls of from 75 to 100-lbs. each, in 2-ft. and 4-ft. widths.

Adlake Flat Flame Long-Time Burner.

Adlake Flat Flame Long-Time Burner.

The Adams & Westlake Co., Chicago, makers of a non-sweating balanced draft type of signal lamps and long time burners for switch and semaphore signal lamps, have recently placed on the market an improved long-time burner, No. 51, which is shown in the accompanying cut. This burner, which has a flat flame, was designed to meet a demand for a lamp, the flame of which would give a greater diffusion to the rays than the round flame burner, which has been in general use. The spread of the flame is approximately $\frac{5}{16}$-in. and is said to be of an intense whiteness. Very satisfactory results are obtained, and the increased oil consumption due to the larger flame is not sufficient to cause any trouble in handling the lamps under established practices.